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ANATOMY AND MORPHOLOGY OF THE BUÑGA AEGINETIA INDICA LINNÆUS[1]

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TEN PLATES

INTRODUCTION

Although many papers have been published on the "buñga" (*Aeginetia indica* Linnæus), an important orobanchaceous root parasite[2] in the Philippines, it seemed desirable to undertake a study on the anatomy and morphology of the vegetative and reproductive organs of this plant because of the harm it is doing in sugar-cane fields in some parts of the Islands, especially Batangas and Laguna.(8, 22, 36, 37) In Calamba Sugar Estate nearly a fourth of the total area devoted to sugar cane is more or less heavily infested with this parasite. Needless to say it is a serious problem and a source of no little worry to the administration. Buñga reduces the sugar content of the canes very considerably(36) and may even cause the formation of substances that render the canes unfit for milling.(22) The present paper is an attempt to describe those phases of the anatomy of the buñga which form a background for a physiological study, and it is hoped this study will result in the development of a basic method of control.

[1] College of Agriculture Experiment Station contribution, No. 1023. Read before the Los Baños Biological Club, July 26, 1934.

[2] This plant is believed to possess medicinal properties by people in some towns of Batangas, where it is said to be cultivated to some extent.

According to Bakhuizen van den Brink,(3) this plant is now found in British East India, Java, New Guinea, Borneo, Philippine Islands, Japan, and China, growing on roots of the Gramineæ, and a few of the Cyperaceæ, Zingiberaceæ, Cannaceæ, Gleicheniaceæ, and Ericaceæ. In the Philippines, buñga is distributed in Luzon from Cagayan to Sorsogon, in all or most provinces, and in Leyte and Panay. It grows in these regions on various coarse grasses at medium altitudes.(35) In Rizal(22) and Negros,(8, 22, 37) as well as in Laguna, this parasite is mostly confined to sugar-cane plants.[3]

Kusano(28) traced the development of the primary tubercle and the primary roots of *Aeginetia indica* Linn.[4] in Japan, and he found that this parasite subsists generally on wild grasses (*Miscanthus sinensis* Anders. and *Carex lanceolata* Boott.) and a few cultivated plants [*Zingiber mioga* Rosc., a mountain rice (*Oryza sativa* Linn.), *Setaria italica* Kth. var. *germanica* Trin., *Zea mays* Linn., *Panicum miliaceum* Linn., and *Panicum frumentaceous* Linn.]. His observation showed that its subterranean parts seem to winter in the vicinity of Tokyo in much the same way that it ratoons with the canes in the Philippines (Plate 9, fig. 90). The seed, according to Kusano, upon germination sends out first a filamentous radicle, its end swelling to form a primary tubercle, when proper host roots are present. Macroscopically he observed that the front of this tubercle penetrates into the cortex of the host root and becomes organically connected with the latter, there differentiating into a primary haustorium. On the upper end the growing point of the stem develops. Simultaneously with the formation of the stem, numerous processes appear from the tubercle as roots of the parasite; these organs possess neither root hairs nor root caps.

[3] February 3, 1934, Mr. Emiliano F. Roldan, of the College of Agriculture, submitted for identification a grass (*Paspalum scrobiculatum* Linn.), which possessed young tubercles of the buñga. This grass, according to Mr. Roldan, was artificially inoculated in a pot of soil. The writer grew this same grass and several other graminaceous weeds, and these were inoculated with seeds of the buñga March 7, 1934. March 28, 1934, the following weeds showed the presence of young tubercles of various sizes from pinhead to about 5 millimeters in diameter: *Eleusine indica* (Linn.) Gaertn., *Eragrostis amabilis* (Linn.) W. and A., and *Paspalum scrobiculatum* Linn.

[4] The English résumé by the author was published by Roxas.(36)

He further stated that both stem and root are formed endogenously.

Later Kusano(29) performed extensive germination experiments on the seeds and he described in detail early stages of germination and development of the young seedling. According to this investigator the seeds did not germinate when immersed in chemicals, and direct contact with the host roots was by no means an indispensable condition in bringing them to germinate. Plants found to induce seedlings to form tubercles were: *Luzula campestris* DC. var. *capitata* Miq., *Carex japonica* Thunb. var. *chlorostachys* (Don) Kük., *C. morrowi* Boott., *Miscanthus sinensis* Anders., *Calamagrostis arundinacea* Roth., *Setaria excurrens* Miq., *Oryza sativa* Linn. (upland form), *Panicum miliaceum* Linn., *Pollia japonica* Hernst., *Zingiber mioga* Rosc., and *Canna indica* Linn. He also found that dry seeds lose viability in two years in Japan.

Coert(13) has described an *Aeginetia*[5] (*A. sacchariсola* Bakh.)[6] plant from Java, which appears to be similar to the Philippine buñga, except in the number of its placentas. Into Coert's description were incorporated many useful observations of the habits and growth of this Javan parasite.

McWhorter,(34) Teodoro,(46) and Roxas(36) attempted to lay out methods of control for the parasite; their recommendations were based largely on the findings of Kusano.(28, 29) Despite all these prescribed methods of combating this plant and the presence of some natural means of control, its spread remains unchecked. If control measures are not found, it may be only a matter of time before its spread will be beyond human control. Some investigators interested in its eradication have diverted themselves with the use of herbicides, or weed killers.(37) Agati and Tan(1) used Atlacide in their attempts to find an effective means of killing this pernicious plant, but they found that their herbicide only helped to prevent seedage, the underground organs remaining unharmed. Later, the same investigators(2) applied DL solution in two concentrations and salt (NaCl) in three concentrations. Their results proved that these

[5] A translation into English of the original article by the author appeared in Sugar News 9 (1928) 367–375.

[6] See Bakhuizen van den Brink.(3)

herbicides also were efficient in killing the aërial organs of the buñga, but its underground parts remained unaffected. In fact, under large scale conditions, these authors observed that new sprouts appeared after the application of the sprays.[7]

MATERIAL AND METHODS

October 13, 1933, some of the material used in this study was obtained from the cultures inoculated June 12, 1933, by Mr. Emiliano F. Roldan. Later collections were made in the Calamba Sugar Estate [8] as well as in the cane fields behind the Protestant Chapel, College of Agriculture, Laguna, in December, 1933, and from January to May, 1934. Artificial germination of seeds in both black and white sand was made in the laboratory, at the College of Agriculture. Before being inoculated, the cane seedlings (POJ 2878) were allowed to grow normally a week or two in the sand; then they were washed off carefully with water and their root systems were covered with the buñga seeds collected in December, 1933, in the Calamba Sugar Estate, and with some obtained through the courtesy of Dr. G. O. Ocfemia. From time to time individual cane seedlings were dug up to be examined for signs of germination and tubercle formation. In all cases the young cane seedlings were moderately fertilized with Nitrophoska.

In cane fields adjoining the grounds of the Protestant Chapel, College of Agriculture, from February to July, 1934, periodically, canes were observed and dug up. These observations were made prior to and after harvesting in order to determine the behavior of this plant parasite on ratoon canes as well as on newly planted cane seedlings.

[7] An endemic root parasite (*Christisonia wightii* Elm.) very closely related to *Aeginetia indica* Linn., was recently reported by Goseco (21) to infest sugar-cane varieties; namely, DI 52, POJ 2878, Badila, New Guinea 24–A, and Negros Purple, in La Carlota, Occidental Negros. According to Elmer (16) his type specimen was collected on Cuernos de Negros, Dumaguete, Oriental Negros, March, 1908, growing in rich damp ground among the tussocks of *Ammomum fusiforme* Ridl. at an altitude of about 1,750 feet. This parasite is also found in Laguna, Bataan, Negros, and Lanao, (35) growing at altitudes of from 400 to 800 meters. Attempts of the writer to grow under laboratory conditions this parasite from seeds obtained through the courtesy of Mr. Federico P. Goseco, of the Research Bureau of the Philippine Sugar Association, have failed.

[8] Thanks are here expressed for the kind coöperation and help extended to the writer by the Calamba Sugar Estate in providing him with suitable specimens of the parasite for this study.

The material, consisting of vegetative as well as reproductive organs, was fixed and killed in the laboratory with the use of formalin-acetic alcohol (70 per cent) and chromo-acetic stock solution prepared according to the formulæ given by Chamberlain.(11) It was treated in the usual fashion and embedded in paraffin. Sections 8 to 10 microns thick were cut and stained in Heidenhain's iron-alum hæmatoxylin with aniline orange G dissolved in clove oil as a counterstain. Free-hand sections of mature vegetative organs were also made, and these were stained in either Heidenhain's iron-alum hæmatoxylin, Delafield's hæmatoxylin-safranin, or safranin-light green.

OBSERVATIONS

THE ROOT

Description.—This obligate parasite possesses numerous white underground roots producing numerous tubercles or swellings, which attach themselves to the host roots by means of sucking organs, or haustoria. The roots of this parasite may be described as white, irregularly ellipsoid, rhizomatous, brittle, and delicate underground organs of small diameters. They branch freely and grow rapidly with the meshes of the cane roots in a hill. In a buñga seedling the primary roots are formed from its primary knoblike outgrowth, or primary tubercle, as was also observed by Kusano,(28) who found neither root caps nor root hairs developing from them. From a single tubercle, numerous roots as well as one to several fleshy, rather large or small, short, aërial, nonchlorophyllose scapes arise. The scapes, which may be 15 to 25 centimeters or more in height, bear few to many scalelike, rather erect, fleshy leaves; each scape is provided with few to many branches or stalks, each bearing a single terminal flower. The aërial organs, except the corolla, pistil, stamens, and seeds, are purplish, longitudinally mottled by yellowish stripes.

Anatomy.—A young root in transverse section (Plate 1, fig. 1) shows an outer layer of parenchymatous, irregularly shaped, epidermal cells, the outer walls of which are often thickened and usually brownish, with granular matter attached to them. Below this single-layered epidermis is a rather extensive cortex of parenchymatous cells, each provided with an abundance of starch grains. These cortical cells are rounded to isodiametric in transverse section and tend to become smaller towards the central cylinder; in longitudinal section they are tubular, with

their end walls set either horizontally or obliquely. The endodermis as well as the pericycle are not well differentiated. The phloëm tissue of the central cylinder has just begun to differentiate. While the endodermis of *Christisonia subacaulis* Gardn.(52) as well as of *Epiphegus virginiana*(14) is not easily distinguishable, that of *Christisonia bicolor* Gardn. is distinct, although its pericycle is not clearly differentiated(52) as it is interrupted here and there by the phloëm elements. In *Aeginetia indica* Linn., however, the cortex of the young root can be easily separated from its central cylinder by the presence of starch grains in the former and their absence in the latter.

The central cylinder of this young root is rather small, and it is devoid of starch grains as stated above. The primary phloëm rays have already differentiated (Plate 1, fig. 1), forming three distinct groups of small, isodiametric parenchyma. The ground tissue is largely composed of thin-walled parenchyma. The elements of the central cylinder are mostly elongated longitudinally with their long axes parallel to the length of the root, their end walls set either horizontally or obliquely.

As the root matures, the triarch arrangement of the vascular bundles (Plate 1, fig. 2) becomes more evident. The primary xylem consists of reticulated tracheids with thickened walls, and the rays often meet at the center of the stele so that the pith is often practically nil. The tracheids are short and rectangular, and all are of about the same size. The primary phloëm rays alternate with the primary xylem rays and are separated by parenchymatous tissue. Sieve tubes, companion cells, and parenchyma are found in the phloëm. The primary phloëm cells are all cylindrical in longitudinal section, rather long, and possess distinct nuclei, while their end walls are usually set horizontally, although obliquely set walls are not uncommon. The absence of vessels in the root is very evident; this very primitive condition of the vascular cylinder in which the xylem has become reduced and the phloëm correspondingly developed exists also in *Christisonia.*(52)

As the root reaches full maturity, it becomes somewhat tough owing to the formation of a sclerenchymatous ring around its central cylinder (Plate 1, fig. 7). The epidermal cells become tangentially flattened in transverse section (Plate 4, fig. 28), their outer walls always remaining thick with granular matter covering them on the outside. The cortical cells are likewise flattened and become somewhat spongy in character, assuming a

variety of shapes. Some of these cortical cells may be rectangular, oblong, or otherwise constricted; all contain an abundance of starch grains. The inner cortical cells of several layers in thickness are lignified, and these lignified cells may actually invaginate the central cylinder (Plate 1, fig. 7). Lignification usually takes place 2 or 3 centimeters from the apex of the root. Simultaneously with the completion of the thickening and lignification of these inner cortical cells, their stored food disappears. Some of these cortical cells may be pitted; they are usually large and variously shaped. The presence of lignified tissue around the central cylinder of the root is reported also in *Christisonia bicolor* Gardn. by Worsdell.(52)

The secondary phloëm (Plate 1, fig. 4) consists mostly of parenchymatous cells with distinct companion cells and sieve tubes. The secondary xylem is composed of groups of reticulated tracheids, the walls of which are very much thickened. These groups of tracheids are often separated from each other by a row or two of distinct parenchyma. Between the secondary phloëm and secondary xylem is an indistinct cambial layer, and this meristematic tissue does not form a complete ring around the central cylinder because of the invagination of the sclerenchymatous cortical cells. In fact, this cambium may be regarded as degenerated tissue as not much secondary thickening takes place in the root.

Occupying the central portion of the central cylinder are the primary xylem rays (Plate 1, fig. 7).

Root apex.—The apex of the root (Plate 4, fig. 30) bears no root cap, as was reported also by Kusano,(28) being entirely covered by a distinct epidermis (dermatogen). The following species are reported to lack root caps: *Christisonia subacaulis* Gardn. and *Ch. neilgherrica* Gardn.,(52) *Epiphegus virginiana,*(14) and *Cassytha filiformis* Linn.(9) Root caps are present in *Aphyllon uniflorum* Gray,(44) *Orobanche speciosa, O. minor, O. ramosa,* and *O. hederæ.*(26) The root apex of the parasite in question has the features of a typical monocotyledonous root without the root cap. The dermatogen consists of squarish to rectangular parenchymatous cells, the thin plerome, of rather much elongated, small, rectangular cells, and the periblem, of large, oblong to rectangular cells. The first covers the root, the second occupies the central portion, and the third represents the bulk of the root. All the cells of these embryonic tissues are provided with dense cytoplasm and distinctly large nuclei.

At the apex of the root may often be found a mucilagelike substance, which is perhaps essential in its growth through the soil and between the host roots.

Origin of primary and secondary roots.—The endogenous origin of the primary as well as the lateral roots as reported by Kusano(28) is herein confirmed. The writer has observed that the development of the primary root from the primary tubercle takes place rather early; that is, the root initials may be seen to differentiate in the tubercle even before the latter has attained a size of 0.5 millimeter. The primary root is first recognized, while still deep in the thin cortex of the tubercle, as a group of embryonic cells (Plate 1, fig. 8). Because of the lack of clear demarcation between the cortex and the central cylinder in the tubercle, the writer was not able to determine with absolute accuracy the particular tissue in the tubercle that gives rise to the primary root. However, these embryonic cells push themselves through the parenchymatous and starchy ground tissue of the cortex of the tubercle, and as this root initial advances outward, those cortical cells behind it gradually form the vascular bundle, which later becomes the central vascular bundle of the primary root. The front of the advancing embryonic cells, on the other hand, forms a distinct row of epidermal cells upon reaching the circumference of the tubercle (Plate 1, fig. 3). Traces of distorted and destroyed cortical cells may be seen along the front of the advancing primary root.

Development of the lateral roots in *Christisonia bicolor* Gardn. and *Ch. subacaulis* Gardn.,(52) as well as in *Epiphegus virginiana,*(14) is closely similar to that in *Aeginetia.* The lateral roots of these plants are first differentiated as a group of embryonic cells pushing out from one of the undifferentiated central bundles.(14) These cells advance through the tubercle, leaving behind a gradually forming bundle that becomes the central bundle of the lateral root. By the time this advancing group of embryonic cells has reached the periphery of the tubercle, it has formed a distinct row of epidermal cells along its apex. In some such roots the cone-shaped apex may still possess a considerable area of embryonic cells containing large nuclei and densely stained cytoplasm. Worsdell(52) states that most probably the pericycle forms the lateral roots in *Christisonia subacaulis* Gardn.

Development of secondary or branch roots in *Aeginetia* takes place very near the apex at right angles to the mother root.

The first indication of the development of a branch root is shown by the activities of the cortical cells at the region between two adjacent phloëm rays (Plate 8, fig. 83). These cortical cells acquire denser cytoplasm and distinctly stained nuclei compared with their surrounding cells, and these differentiating cortical cells become somewhat actively engaged in division at all planes so that they form a distinct strip of meristematic cells. Later, organization of the embryonic tissues of the young branch root takes place (Plate 8, fig. 84), and as this young branch root pushes itself through the cortical cells of the mother root, those cells left behind form the vascular bundles of the young branch root, similar to that obtaining in the primary root (Plate 1, fig. 3). As this root emerges from the cortex of the mother root, it forms a distinct epidermis on its front.

General consideration.—The tracheids of the stele and the sclerenchymatous cylinder of the cortex in the mature root stain red with phloroglucin-hydrochloric acid. When roots are exposed to the air, the cortex readily loses its water content, and darkening of the root takes place at once. This darkening is perhaps due to the abundant tannin in the cell sap of the cortical cells. Storage of starch grains takes place mainly in the cortex, a tissue which easily allows the escape of moisture upon exposure to air, while the sclerenchymatous cortical cylinder shuts off the central cylinder from the food supply stored in the mature root.

The cellulose nature of the outer walls of the epidermis as well as the cortical tissue of the root does not preclude the possibility that water absorption may not take place at all through this underground organ. Intake of water with dissolved mineral matter from the soil may be possible only at regions where the cortical sclerenchymatous cylinder has not yet fully developed, and this usually takes place far from its apex. In fact, Cooke and Schively(14) were even tempted to state that the roots of *Epiphegus virginiana* are also perhaps for the absorption of water.

In numerous excavations made by the writer in cane fields planted to POJ 2878 behind the Protestant Chapel, College of Agriculture, Laguna, from February to June, 1934, where this buñga was producing only one to two clusters of fresh flowers in late February, the underground organs of this parasite were found to be still fresh and connected with the cane roots. As the fruit matures, the main axis of the scape becomes dry, and

breaks off early from the fresh underground tubercle. Termites also help in mechanically detaching the scapes from the tubercles. When the canes were harvested in March, 1934, these aërial parts of the buñga were mechanically destroyed and their seeds disseminated. Some of the seeds and remains of the aërial organs might have been destroyed by fire when the trash was burned. In fields where the ratoon canes were allowed to grow, excavations made April 28, 1934, showed that the roots of the old buñga were still fresh and were attached to the cane roots (Plate 9, fig. 90), despite the fact that the fire had cleared the field of rubbish. In several instances the writer observed that even ordinary secondary roots of the parasite may start to develop scapes without first forming tubercles. What was of greater import to the writer was the development of a scape at the injured apex of the root (Plate 9, fig. 91, A). It seems quite possible that the buñga was stimulated somewhat by the heat of the fire to produce an abundance of reproductive organs. In other words, scapes are not only produced from either primary or secondary tubercles (Plate 9, fig. 91, B), as reported by Kusano,(28) but these reproductive organs may also be formed by ordinary roots of the parasite, especially in ratoon canes. Later visits to the same field showed that the buñga had actually become biennial (Plate 10, fig. 92), and perhaps would become perennial if left on the same ratoon cane for a number of years. This same behavior of the parasite has been observed in the Calamba Sugar Estate on ratoon canes (PSA 14 and POJ 2878).[9] It is apparent that ratooning canes are favorable to the perennial growth of this parasite.

Another field just as heavily infested with buñga as the one specially observed and adjacent to these ratoon canes, was planted to POJ 2878 canes April 15, 1934. The soil was well prepared, and excavations made by the writer about the middle of May, when the canes were 2 to 3 feet high, and June 14, 1934, when they were 4 feet high, showed no sign of infection, indicating that perhaps the old parasite had been completely killed, and infection must of necessity have come from old seeds.

From the foregoing anatomical characteristics of the underground organs of this parasite, the writer is inclined to believe that infestation of new seedling canes under field conditions by chips of roots detached from the host is not only improbable

[9] From the monthly report of the Calamba Sugar Estate Research Department for June, 1934.

but impossible. Infestation of these new cane seedlings must be attributed to seeds left by previous crops of the parasite. Besides, the ease with which moisture actually escapes from its roots makes it less difficult to prevent further growth of the root pieces, especially if exposed to air prior to their being carried to the roots of the new cane seedlings. In fact, the time needed to prepare the land for the next crop of cane, and the rigorous method of cultivation followed prior to planting the cane points, are enough to desiccate the roots of the parasite. True, comparatively few seeds actually germinate in nature, as a great number of them are germless, but only one seed is necessary to infect a hill of canes as the young seedling parasite can vegetate quite successfully (Plate 10, fig. 93).

It is highly probable that a tubercle or even a segment of the parasite may continue to produce roots and reproductive organs when perchance it is mechanically severed from its parent parasite, provided this severance is preceded by the establishment of organic connection between the severed segment and the host root—a point that needs further study. Otherwise, the detached part or segment will die. Infestation of nearby hills may take place if the canes are planted so near each other as to allow their root systems to overlap. In fact this parasite can grow at some distance from the hill.

In connection with the infestation of new cane seedlings by a mature parasite, the possibility of infesting new cane plants with old stumps of the parasite left attached to the old host canes must be admitted, especially under controlled laboratory conditions, where factors are made so favorable for growth. To test this possibility one would have to eliminate all the seeds clinging to the parasite and the cane stumps. This means of infestation, if possible, is, in the writer's opinion, analogous to, if not identical with, conditions obtaining in ratoon canes already infested with the parasite. While the parasite that is made to infest new canes can hibernate or even continue to produce new tubercles and reproductive organs as it has an abundance of stored food and organic connection with the old host roots is not destroyed, it can transfer to the new cane seedling in much the same way as the parasite on ratoon canes and renew its growth on roots arising from the developing buds of the old ratoon canes in the field. This phase of botanical inquiry, which awaits verification, has some important significance in the control of the parasite.

THE TUBERCLE

Kusano(29) described in detail the development of a primary tubercle soon after germination of the seed. According to him, after the hair-tendril cells are formed by the germinating seed, the cells below this filamentous radicle form a spherical or oval primary tubercle by rapid cell multiplication. This parenchymatous tissue of the young tubercle pushes and breaks the hair-tendril cells, and comes to lie in contact with the host root. Until organic connection is made, cell multiplication within the tubercle is due to the reserve food in the parasite, and Kusano claims that the young tubercle may attain the full size of about a millimeter with the help of its endosperm.

The anatomical structure of the tubercle as found by Kusano(28) is herein given. The tubercle possesses numerous vascular bundles of a peculiar appearance, and these are scattered on the ground parenchyma filled with an abundance of starch grains. Surrounding the tubercle is an epidermal layer of cells which may be broken at intervals, and these epidermal cells have their outer walls heavily stained by hæmatoxylin. At regions where the epidermis is broken or discontinuous, the outer cortical cells actually function as the epidermis. Below the epidermis is the cortex consisting of large, parenchymatous cells provided with an abundance of starch grains. This cortex is continuous with that of the main root and usually incloses the region containing the vascular bundles (Plate 1, figs. 5 and 6; Plate 2, fig. 15).

Scattered on the ground parenchyma of the central portion of the tubercle are vascular bundles. In the middle of the individual bundle (Plate 2, fig. 11) are few to numerous lignified, thick-walled tracheids with reticulate thickenings. Surrounding these tracheids are one to several layers of small, more or less elongated, parenchymatous cells, with very dense cytoplasmic content and rather large nuclei. Separating the individual small or large bundles are few to several large layers of other parenchymatous cells, with clear nuclei and not as dense cytoplasm as those found directly surrounding the tracheids. Two or more vascular bundles may fuse on entering a haustorium, while their branches diverge towards the central cylinder in the mother root. A direct connection with the central cylinder cannot be discerned; their ends appear to dip away into the cortex. The absence of a sclerenchymatous ring of cells around the central cylinder is manifest. The formation of such prominent and

peculiarly disposed vascular bundles has also been described in the tubercle of *Christisonia subacaulis* Gardn. by Worsdell,(52) who believes that their presence in the tubercle affords a good way of distributing the food absorbed from the host to points where shoot and root formation is very active.

The formation of the primary tubercle is relegated to the seedling, but that of the secondary tubercles, to the primary as well as to branch roots, and the structure of the secondary tubercle is similar to the primary tubercle. The development of the secondary tubercle is macroscopically indicated by a distinct enlargement of the secondary or primary roots—an enlargement which is often asymmetrical at first, becoming rounded later. Internally the cortical cells of the root of the parasite, adjacent to the host root, exhibit very active divisions in all planes (Plate 2, fig. 10; Plate 8, fig. 85), so that the secondary root often reveals a heterogeneous cortical tissue. The cortical cells away from the host root are large, rounded, and more or less spongy in character, while those facing the host root are much smaller and possess distinct nuclei and denser cytoplasm. In the latter cells, starch grains are not abundant, and this is perhaps due to their rapid consumption during cell divisions. Later, some of the cortical cells divide radially, so that rows of radially elongated cells are formed, which become the forerunners of the vascular bundles in the young developing tubercle (Plate 8, fig. 86).

THE HAUSTORIUM

How connection with the host root is effected in an *Aeginetia* seedling is described by Kusano.(29) He found that upon germination the seed sends out from its radicular end two or three large, hyaline, globular cells, which are highly turgescent, and each is provided with abundant cell sap. Their nuclei are large and conspicuous, and the cytoplasm radiates from them. Those globular cells increase in number generally up to fifteen, approximately, comprising the epidermal cells of the radicular end of the embryo, swelling to nearly four times their original diameter. Kusano claims it is improbable that multiplication of cells may be partly concerned in the increase in size. Each globular cell protrudes its external wall, which has first a conical and then a papillalike form. These outgrowths proceed further to form slender hairs, some of which grow to a length of about a millimeter. These hairs are either septate or even branched, and are rhizoidal in character. They usually grow straight and

radiate in all directions if undisturbed; if they come in contact with the host root, they seem to attach themselves firmly to it, and then coil or contract through their whole length, whereby the seedling is drawn closer to the host. Kusano was not able to determine with absolute accuracy how the hairs fix themselves on the host root. The hypodermal cells below the hair-tendril cells of the embryo form the tubercle, which penetrates the host root, and thus becomes organically connected with the host root by means of a haustorium.

In *Orobanche*(27) the radicular half of the embryo develops into a filamentous radicle, the plumular half remaining throughout in the endosperm acting as an absorbing agent. Parasitism here is effected by the root tip.

The seed of *Phelipaea ramosa,*(10) upon germination, sends out a long, filamentous, multicellular radicle devoid of root hairs, the end of which is enlarged. This radicle pushes itself through the endosperm, while the chalazal end of the embryo gives rise to the stem. The tip of the radicle penetrates the cortex of the host root. Vascular bundles of the root are developed, but no connection can be seen between its main bundle and the haustorium. The upper end of the haustorium enlarges and later sends out adventitious roots.

Massee(33) pointed out that the seed of *Lathraea squamaria* Linn. sends out a tap root upon germination, and this root gives off numerous branches, each furnished with minute hemispherical suckers or haustoria. The root forms short root hairs and these penetrate between the epidermal cells of the host, while the central vascular portion penetrates deeply until it reaches the pericycle of the host from where it absorbs nutriment.

How organic connection is made by *Melampyrum pratense* with its host has been fully described by Leclerc du Sablon.(30) The two-layered cortex of the root greatly elongates at the region facing the host root, and the cells there divide in various directions, forming a swelling; the epidermal cells, which were first isodiametric, send out lateral protuberances. One of the epidermal cells towards the host elongates tangentially at first, and then divides radially or anticlinally several times, some of its daughter cells actually elongating. These elongating cells form rootlike outgrowths, which penetrate the host root. The pericycle does not in any way remain inactive and its cells elongate and later divide periclinally at the region contiguous to the enlarged cortical region, simulating the formation of a

branch root; this forms the major portion of the haustorium. This activity of the pericycle presses down the endodermis so that it actually disappears at this region of the root. The piliferous layer may, in certain cases, exhibit very active radial divisions, the daughter cells of which elongate to form a compact mass of hairs. These hairs also penetrate the host roots. Hairs formed by the epidermal cells grow into the host much as the mycelia of a fungus penetrate its host, dissolving the host cells on their way by simple diastase reaction. These hairs form a "vascular system" with spiral thickenings, and differentiation of their reticulations proceeds until there is formed a continuous canal from the hairs to the central cylinder of the main root. A similar development of the haustorium has been described by this investigator for *Melampyrum cristatum, M. silvaticum,* and *M. nemorosum.* In *Tozzia alpina,* as well as in *Rhinanthus* (*Alectorolophus*) and *Pedicularis,* Leclerc du Sablon(30) believes the haustorial development is identical with that of *Melampyrum.* Barber(4, 5, 6) is of the opinion that the formation of haustoria in *Olax scandens* and *Santalum album* is similar to that given by Leclerc du Sablon(30) for Rhinanthaceæ (Scrophulariaceæ).

In *Christisonia bicolor* Gardn.(52) the external cells of the root at the point of contact divide in places, and the cells for some distance on either side become elongated radially, while they become filled with dense cytoplasmic content and exhibit conspicuous nuclei; at the same time cortical cells immediately below this layer divide rapidly in succession in several directions; a few divisions occur in those more deeply situated. As a result of those cell divisions in the initial stage of haustorial formation, the cortex bulges considerably. A few cells on either side of the point of contact grow into hairlike papillæ, which possess thick walls and dark brown contents with prominent nuclei. These grow towards the host root. The portion of the cortex at the point of contact at length, by repeated divisions in the cells, grows out as the haustorium, the cells in contact being much elongated and more or less contorted, with dense cytoplasm. Its origin is, therefore, exogenous, and no sieve tubes are present. Its development is quite different from that of *Rhinanthus* and *Cuscuta.*

In *Aeginetia indica* Linn. the writer believes entrance into the host root is effected by the pressure exerted by the enlarging epidermal and cortical cells of the tubercle facing the host root (Plate 2, fig. 13). The haustorium then penetrates the host

cortex through the endodermis into the stele of the sugar-cane root (Plate 2, fig. 15). The ground tissue of the haustorium is parenchymatous, and its cortex is continuous with that of the tubercle. The cells (Plate 2, fig. 12) that abut the vessels of the host root are variously shaped, and contain dense cytoplasm. These cells become somewhat tubular to rectangular upward in the haustorium. Some of the central cells of the haustorium may become reticulately thickened and form the conductive system connecting the parasite with the vascular bundles of the host root. Connection is made not only with the xylem vessels but also with the phloëm tissue of the host root, so that the parasite actually draws water and elaborated food from the host.

The haustorial bundle branches into two or more divergent bundles before passing into the central cylinder of the tubercle, and these bundles may oftentimes dip away into the cortex without exhibiting actual connection with vascular bundles of the main root. Worsdell(52) claims that in *Christisonia* these bundles act as storehouses for the spoils of the haustorium, and by traversing the enlarged cortical tissue in all directions aid greatly in distributing the nutriment throughout the tissues of the tubercle so formed, supplying the young lateral roots and scapes with an abundance of food.

THE SCAPE

General consideration.—The scape arises endogenously(28) from the tubercle. Under laboratory conditions, scapes are formed about two to three months after inoculation of the cane seedlings in sand. In the formation of scapes the tubercle (Plate 9, fig. 91, *B*) is the one organ responsible for their development, but in ratoon canes the writer has observed that scapes may arise directly from the main root of the parasite without first forming a tubercle (Plate 9, fig. 91, *A*).

Under field conditions the buñga usually flowers more or less simultaneously with the sugar cane or oftener ahead of it. Even after the canes are harvested, the buñga may continue to produce reproductive organs (Plate 9, fig. 90), perhaps to tide them over until the ratoon canes have started to grow again. Actually, however, the parasite starts to form scapes from its tubercles long before the flowering season of the sugar cane comes. Simultaneously with the development of the scapes and their emergence from the soil, the sugar-cane plants form a thick covering over the area that conceals the flower buds of

the parasite. When the canes are so tall that their basal leaves have dried up, a clearer view of the basal portion of the canes is obtainable, and at this time the buñga flowers are maturing. It is only at this stage of development that the buñga is actually recognized in the field, and by this time the damage to the canes has been done, and buñga-seed production is perhaps at its best. As the buñga is an ombrophyte, its aërial organs are less vigorous and may even degenerate when this parasite is growing under direct sunlight. Consequently it does better in the shade, a condition most favorable also to the growth of the Javan *Aeginetia saccharicola* Bakh., which was reported by Coert.(13)

The scape is colorless before its emergence from the surface of the ground, and forms its peculiar pigmentation on exposure to air. It is short, terete, somewhat rigid, atropurpureous, 1 to 5 centimeters, rarely up to 15 centimeters, long, and from 0.3 to 1 centimeter in diameter.

Origin.—The endogenous origin of the scape as reported by Kusano(28) is correct. A group of embryonic cells is differentiated deep in the cortex of the tubercle (Plate 8, fig. 87) and as these cells grow outward through the cortex, the parenchymatous cells behind them form vascular bundles to the scape. These embryonic cells, as they approach the periphery of the tubercle, cut off lateral protuberances (Plate 8, figs. 87 and 88), which form the scale leaves acting as protective covering to the growing point of the scape (Plate 2, fig. 14; Plate 8, fig. 89).

Anatomy of the main axis.—A transverse section of the central axis to the scape, taken at or near its attachment to the tubercle, reveals the presence of bicollateral vascular bundles arranged in a ring on a ground parenchyma filled with an abundance of starch grains (Plate 2, fig. 16; Plate 4, fig. 33). It is somewhat circular in outline, and is surrounded by a distinct epidermis of small, oblong to rectangular or squarish cells, the outer walls of which are somewhat papillate. In the sap of the epidermal cells is dissolved the pigment to the scape. Inclosed by this epidermis is a thin cortex of small or large, oblong to rounded, tubular, parenchymatous cells, which are loosely packed together, and each is provided with a copious supply of starch grains. These cortical cells are smaller near the epidermis and become progressively larger towards the

stele. The endodermis, or starch sheath, and the pericycle are not differentiated in this organ, as is true of *Christisonia subacaulis* Gardn.(52)

The individual vascular bundle (Plate 2, fig. 16) is more or less rhomboid, and is inclosed by a bundle sheath consisting of three or four layers of sclerenchymatous cells. Surrounded by the sclerenchymatous bundle sheath is the phloëm, which consists of distinct companion cells, sieve tubes, and parenchyma. The interior and exterior phloëms have the same structure. The few tracheids, which occur in groups, are arranged in small broken rings and have thickened walls and reticulated thickenings. These surround a group of parenchyma at the center of the bundle. Separating the groups of tracheids and the phloëms is an inner and outer discontinuous cambiumlike tissue one to two layers thick.

The bicollateral bundles are separated from each other (Plate 2, fig. 16; Plate 4, fig. 33) by few to several layers of cells similar to those found in the cortex; these are filled with starch grains.

The pith is made up wholly of large, parenchymatous cells with a copious supply of starch grains and mostly rounded to isodiametric in transverse section, similar to those present in the cortex.

The number of vascular bundles of the main axis increases upward as a result of branching, and this is correlated with an increase in diameter. The epidermis and the cortex remain as before, while the pith is somewhat enlarged and possesses the same characteristic cell structure as described above. The bicollateral bundles are more numerous and lie closer together (Plate 3, fig. 17), forming at times an almost continuous ring owing to the fusion of their sclerenchymatous bundle sheaths. In the majority of these bundles the sclerenchymatous sheath actually invaginates radially into the bundle from its outer tangential side, thus forming a U-shaped bundle (Plate 3, fig. 17).

The individual bundle is also bicollateral (Plate 3, figs. 17 to 19). The tracheids are arranged in groups and separated by parenchyma. On the outer and inner tangential sides are the phloëm groups which consist of sieve tubes, companion cells, and parenchyma. Separating the tracheid groups and the phloëms are scattered cambiumlike cells.

Worsdell(52) observes the presence of a ground tissue of hexagonal to rounded cells filled with starch grains, and the vascular bundles are arranged in an irregular ring in the stem of *Christisonia*. These bundles lie side by side in groups, separated by wide spaces of ground tissue. The individual bundle is circular in outline and is concentric in *Christisonia neilgherrica* Gardn. In stems of *Aphyllon uniflorum* Gray,(44) as well as in *Epiphegus virginiana*,(14) bicollateral vascular bundles are present; these stems possess an abundance of starch grains, which pass into the soil with the decay of the plant.

The main axis is devoid of stomata and trichomes, and is entirely glabrous. In *Christisonia neilgherrica* Gardn. stomata are present, rising above the surface of the stem, while in *Ch. subacaulis* Gardn. and *Ch. bicolor* Gardn. stomata are entirely absent.(52) Cooke and Schively(14) attribute the withering of *Epiphegus virginiana* after several of them have attacked a host, to the presence of numerous stomata. In *Aeginetia indica* Linn. nonresistance to the desiccating effect of direct sunlight is due to the absence of a heavy protective coating on the surface of the scape.

At maturity of the fruits, the main axis of the scape decays and actually becomes separated from the tubercle that bears it. Decay of the main axis begins at its epidermis, and proceeds into the cortex and into the pith at times; only the skeleton of the vascular bundles is left to hold the scape erect. At a slight mechanical pressure this scape becomes automatically severed from the parent parasite, and thus helps in disseminating the seeds.

Scale leaves.—The main axis of the scape bears a few to several scale leaves, which are spirally arranged on it (Plate 3, fig. 20). Each of these scale leaves subtends at its axil a branch or pedicel, which carries at its apex a single flower (Plate 5, fig. 34). At maturity each scale leaf is more or less glabrous, somewhat erect at first, later becoming horizontal, oblong ovate, small, and acuminate, acute or even obtuse, its base more or less clasping the main axis. It is about 0.5 to 2 centimeters long, and 0.3 to 0.5 centimeter broad. Because of the elongation of the main axis above a scale leaf, the pedicel or branch subtended by the scale leaf is carried way up, so that at maturity the scale leaf is borne far away from the pedicel or branch that it subtends.

In transverse section the scale leaf is lunar in shape (Plate 3, fig. 20) and possesses distinct epidermal layers consisting of small, laterally compressed, rectangular cells on the dorsal or nether surface, and large, rounded to isodiametric cells with papillate outer tangential walls on the ventral or upper side (Plate 1, fig. 9). In these epidermal cells the pigment of the scale leaf is found. These epidermal cells are all elongated in surface view with their long axes parallel to the length of the scale leaf, their end walls being mostly set horizontally, although a few of them may be set obliquely. The mesophyll is occupied by loosely packed, parenchymatous cells, which are isodiametric; in this mesophyll are distributed the vascular bundles. These vascular bundles, which are poorly developed, lie near the ventral or upper side of the scale leaf. A single vascular bundle enters a single scale leaf, and this single bundle branches out several times as it traverses the whole length of the mesophyll of the scale leaf.

On the upper side of the scale leaf are often a few, well-developed stomata consisting of two very much elongated, bean-shaped, guard cells, with their long axes parallel to the length of the scale leaf. The first organ of the parasite to show signs of desiccation is the scale leaf, and this susceptibility to drying is due perhaps to the presence of few of those natural openings. On the scale leaves of *Aphyllon uniflorum* Gray(44) stomata are found on the undersurface, while in those of *Christisonia subacaulis* Gardn.(52) stomata and mucilage-secreting glands are found scattered on their ventral sides.

Stalk or pedicel.—Subtended by a scale leaf is a stalk or pedicel (Plate 3, fig. 20), which holds a single flower at its apex (Plate 5, fig. 34). It is more or less erect, terete, and thickened upward, glabrous, atropurpureous, 10 to 30 centimeters long, and 0.1 to 0.4 centimeter in diameter.

In transverse section the young pedicel shows the presence of distinct groups of procambial strands (Plate 3, fig. 21) arranged in a ring on a ground of parenchymatous tissue. The epidermis consists of radially elongated cells, in which is found the pigment, and these epidermal cells inclose a rather wide cortex of thin-walled cells. The cortical cells are rounded to oblong and larger than the epidermal cells. The pith cells are similar to those found in the cortex and this ground parenchyma is provided with an abundance of starch grains.

As the stalk or pedicel matures, its epidermal cells become tangentially flattened, and are rectangular or more or less elongated vertically. The cortex becomes proportionately smaller and thinner, and consists of several layers of large, rounded to isodiametric, parenchymatous cells in transverse section, between which are small intercellular spaces. These cortical cells contain starch grains and tend to become larger from the epidermis inward to the middle portion, and gradually become smaller again towards the stele. The endodermis is indistinct or perhaps absent.

The individual vascular bundles (Plate 4, fig. 29) are collateral, and arranged in a ring. The phloëm, which forms the major portion of a bundle, consists of distinct parenchyma, companion cells, and sieve tubes. Running radially through the phloëm are uniseriate or biseriate rows of hexagonal ray cells. The sieve tubes and companion cells occur in groups. The xylem, which lies towards the pith, is composed of groups of reticulated tracheids with thickened walls and separated by parenchyma. Between the tracheids are also found the hexagonal ray cells. The xylem and the phloëm are usually separated by distinct cambium consisting of one or two layers of cells occurring in patches.

The pith is occupied by large, rounded, parenchymatous cells rich in starch grains and intercellular spaces.

The mechanical tissues to the pedicel consist of the sclerified and lignified inner cortical cells (Plate 4, fig. 29), as well as the lignified groups of cells separating the individual bundles and the peripheral pith cells. All these lignified tissues contribute to the rigidity of the pedicel.

At maturity of the fruit, the pedicel turns black first at or near the point of its attachment to the capsule, and this blackening progresses downward to the main axis of the scape. The pith cells are resorbed, and at the time the pedicel is dry, the pith is hollow. With the decay of the pedicel the unused starch grains in the cortex pass into the soil.

Stomata are absent on the pedicel of *Aeginetia indica* Linn.; they are present in *Conopholis americana*(51) and *Aphyllon uniflorum* Gray.(44) In *Conopholis* there are two concentric rings of separate collateral vascular bundles, the respective phloëms of both rings facing each other.

The flower.—Each scape develops from one to a dozen flowers (Plate 5, fig. 34), each of which is long-pedicellate. Its calyx is ovoid, compressed, its base inflated, apex acute, more or less apiculate, coriaceous, glabrous, and very much shorter than the corolla. Externally it is purplish with longitudinal yellow stripes; internally it is white or pale yellow, becoming blackish purple upward on its dorsal side. It measures from 1.5 to 3 centimeters, rarely as much as 5 centimeters, in length and 1 to 1.5 centimeters in diameter. Inclosed by it is a colorless, mucilaginous liquid secreted by multicellular glandular hairs (Plate 5, figs. 38 and 39) on its inner surface.

Anatomically the calyx (Plate 3, fig. 22) has a distinct outer and an inner epidermal layer. The outer epidermal cells are much smaller than the inner, and their outer tangential walls are papillate. On surface view the outer epidermal cells are oblong to irregularly trapezoidal or nearly isodiametric with straight walls. The inner epidermal cells are much larger than those from its outer epidermis, more or less rectangular to oblong or even rounded in shape, their outer walls somewhat papillate, but almost always straight. On surface view these are identical with those of the outer epidermis of the calyx, but above the vascular bundles the epidermal cells are somewhat elongate. Both epidermal layers bear the pigment of the calyx. On the inner epidermis are borne, here and there, numerous glandular hairs, or trichomes (Plate 5, figs. 38 and 39), consisting of a uniseriate, a few- to several-celled stalk and a multicellular, glandular apex, the cells of which are often pigmented. In *Epiphegus virginiana*(14) the trichomes are on the outer portion of the calyx and absent from the inside, while in *Christisonia bicolor* Gardn.(52) the trichomes are borne inside. Stomata are absent from the calyx of *Aeginetia indica* Linn., but abundant on both surfaces of the calyx of *Christisonia neilgherrica* Gardn.(52) and *Aphyllon uniflorum* Gray.(44)

The mesophyll has a ground tissue of large, loosely packed, rounded to isodiametric, thin-walled cells with few to abundant starch grains in the inner half of the calyx. The vascular bundles are located near its inner epidermis.

The corolla is 2-lipped, tubular-campanulate (Plate 5, fig. 34), and its five lobes are more or less reniform, rotund or suborbicular, obscurely crenate, unequal or subequal, 0.25 to 1 centimeter long, and about 0.5 to 1 centimeter, rarely 1.75 centimeters, broad. It is twice, or even thrice, as long as the calyx,

curved at the insertion of the stamens, 2.5 to 5 centimeters long. At its basal portion it is more or less constricted above the ovary. Externally the corolla is pale purple, deepening near the calyx, and white at its base. Internally it is deep purple in the region around the pistil and at its mouth. It is thinner and more delicate than the calyx, and usually dries off easily.

This corolla possesses an outer layer of epidermal cells (Plate 3, fig. 23), which are rectangular, tangentially flattened, and with often papillate outer walls. The inner epidermal cells are much larger than the outer. From these epidermal cells of both inner and outer layers are developed numerous glandular trichomes (Plate 5, fig. 39) similar to those found on the calyx. Stomata are absent on the corolla of *Aeginetia indica* Linn., but present in *Aphyllon uniflorum* Gray.(44)

The mesophyll consists of loosely arranged cells provided with starch grains, leaving between them large air spaces. Vascular bundles, which lie nearer its inner epidermis, traverse the mesophyll.

The stamens are four in number (Plate 3, fig. 24), epipetalous and didymous (Plate 5, fig. 34), very similar to those found in *Christisonia.*(52) At maturity these are united at their anthers owing to the secretion of a thick mucilage by the glandular trichomes found on the filaments near their attachment to the connectives (Plate 3, fig. 26). The anthers are violaceous in color, and bilocular when young (Plate 3, fig. 24; Plate 5, fig. 41), each locule being more or less crescent-shaped, owing to the projections of the broad, conical band of sterile tissue from the connective. At maturity of the anther, however, the wall partition between the two loculi breaks away, so that the anther becomes unilocular. Each of the two posterior stamens has a peculiar swollen prolongation, or spur, from the connective, which is deflexed and equal in length to the anther, arising near the attachment of the filament. This spur (Plate 3, fig. 25) is somewhat oblong in transverse section, and is filled internally with a parenchymatous ground tissue delimited by a distinct epidermal layer. The parenchymatous ground tissue possesses large intercellular spaces, and is traversed by a single large central vascular bundle that never reaches its apex. The filaments are white, rather slender, and more or less curved. Each of the filaments is somewhat polygonal in transverse section (Plate 3, fig. 26) and consists of large, rounded, parenchymatous ground

tissue with large to small intercellular spaces and an abundance of starch grains. On the outer portion of the filament is a single layer of epidermal cells. On this epidermis are borne glandular hairs (Plate 5, fig. 39) similar to those formed on the calyx and the corolla, and these hairs secrete mucilage cementing the anthers together long before anthesis. The glandular hairs are mostly at or near the attachment of the filament to the connective of the anther. Traversing the ground parenchyma of the filament is a single vascular bundle.

The stigma is rather large (Plate 5, fig. 34), cordate-pileate, white to yellowish white, and 0.3 to 0.35 centimeter in diameter. It is covered with numerous hairlike processes, which are much elongated and somewhat pointed (Plate 4, fig. 32). Within these elongated cells, the cells are rather loose and contain an abundance of starch grains. On these expanded, elongated processes of the stigma, the microspores germinate (Plate 4, fig. 32).

The style is somewhat cylindrical, inflexed, glabrous, white, hollowed in the center (Plate 3, fig. 27), and from 1.5 to 2 centimeters long. It is covered by a distinct epidermis consisting of small, radially elongated, papillate cells, inclosing a ground parenchyma of loosely packed cells showing distinct air spaces, and provided with starch grains. Bordering on the central cavity are groups of elongated cells which are papillalike and swollen with mucilaginous secretions. These secretions are, perhaps, conducive to the growth of the male gametophyte. Two vascular bundles traverse the style throughout its length.

The ovary is ovoid (Plate 5, fig. 34), conical near the stylar end, cordate at the base, pale yellow, glabrous, 1 centimeter long, and 0.7 to 1 centimeter in diameter. It is bicarpelled (Plate 3, fig. 24; Plate 5, fig. 46), and unilocular throughout. Borne on the wall of the ovary are two opposite, lamellate placentas, their free lamellæ being irregular, deeply branched, and intensely plicate, becoming membranous at maturity of the fruit. These placentas extend into the ovarial cavity and lie through the whole length of the ovary. On the surface of the placentas are borne numerous anatropous megasporanges, which are extremely small. On the ground parenchymatous tissue of the ovary wall and the placentas is an abundant supply of starch grains.

The unilocular ovary with four placentas is also reported in *Christisonia bicolor* Gardn.,(52) *Aphyllon uniflorum* Gray,(44) and *Epiphegus virginiana.*(14) Of the four species of *Aeginetia* reported from the Netherland Indies by Bakhuizen van den

Brink,(3) *Aeginetia indica* Linn. has four placentas, the rest have only two.

Organography of the flower.—The development of the floral organs is acropetal and they arise as follows: Calyx, corolla, stamens, and pistil. The earliest stage the writer was able to obtain was when the primordium of the pedicel to the flower has emerged from the axil of the scale leaf (Plate 2, fig. 14; Plate 5, fig. 35; Plate 8, fig. 89). It appears as a hemispherical mass of meristematic cells, which elongates first, and at its terminus the flower is developed. The first floral organ to emerge from this floral primordium is the calyx, and this is followed by the corolla (Plate 5, fig. 36). Within the corolla, small mammillate protrusions emerge as the primordia of the stamens (Plate 5, fig. 37), and these are followed by the formation of the carpels on the apex of the floral primordium. The calyx has a definite growth, so that the corolla has to break its way through it long before anthesis (Plate 5, fig. 34).

MICROSPORANGE AND MICROSPORES

The anther shows two distinct lobes in transverse section (Plate 3, fig. 24; Plate 5, fig. 41), and with a slight prolongation on the opposite side of the attachment of the filament. Under each lobe, one or more rows of cells (Plate 5, fig. 42) situated on the third layer below the epidermis, differentiate as the sporogenous tissue. These cells are easily distinguished from the surrounding cells by the density of their cytoplasm and by their heavily stained, large nuclei. This sporogenous tissue forms a solid crescent-shaped band on each lobe (Plate 5, fig. 41) and is continuous through the whole length of the anther.

Of the parietal tissue, which is two-layered (Plate 5, fig. 42) at first, the layer directly in contact with the sporogenous tissue functions as the tapetum. These tapetal cells elongate radially and become binucleate or even trinucleate at the time the microspore mother cells are in synapsis. The increase in the number of nuclei of the tapetal cells results from the divisions of their nuclei.

The outer parietal layer of cells (Plate 5, fig. 42) may increase in thickness by a few periclinal divisions during the development of the anther (Plate 5, fig. 43). As the microspores are formed, this parietal tissue is actually destroyed or consumed, except the hypodermal layer which forms the endothecium in the mature anther (Plate 5, fig. 49).

The sporogenous tissue by subsequent divisions forms a mass of microspore mother cells (Plate 5, fig. 43). As the microspore mother cell enters synapsis (Plate 5, fig. 44), its cytoplasm usually shrinks away from its original wall, and proceeds to divide successively to form the tetrahedral tetrads (Plate 5, fig. 45), at which time the original wall of the mother cell has already disappeared. The tetrads are at first embedded in a special gelatinous coat (Plate 5, fig. 45), and as this coating eventually dissolves (Plate 5, fig. 47), the microspores are liberated. The young microspores then round off, and acquire their own coats. Long before dehiscence the single nucleus of the individual microspore undergoes division so that it becomes binucleate (Plate 5, fig. 48). Each microspore then possesses a large rounded and distinct vegetative nucleus, and a small, lenticular, rather densely stained generative nucleus. Successive division of microspore mother cells has also been reported in *Epiphegus virginiana.*(14) Among other parasites in which binucleate microspores have been reported are: *Viscum album,*(41, 42) *Rhopalocnemis phalloides* Jungh.,(32) *Rafflesia patma* Bl.,(19) and *Epiphegus virginiana.*(14) However, in *Rhopalocnemis phalloides* Jungh.(32) trinucleate microspores are sometimes present.

Gates(20) has observed that the wall of the microspore mother cell in *Lathraea* usually remains in contact throughout the whole process of meiosis until its final dissolution. It does not round off and separate from its sister cells completely. Instead, a special microspore mother cell wall, often of great thickness, develops inside the original wall, and this special wall may lie in contact with or be clearly detachable from, the mother wall. From this special wall wedge-shaped protrusions into the cytoplasm from four equidistant peripheral points become visible. After the formation of these wedges, active furrowing of the cytoplasm takes place, and the peripheral wedges are prolonged by passive deposition of wall materials and not by invagination. The prolongation of the peripheral wedges progresses towards the center. Simultaneously with this formation of wall from the special microspore mother wall, the original wall remains, and later dissolves, leaving the special mother wall exposed, which in turn dissolves liberating the four microspores. The writer was not able to follow this very closely in *Aeginetia,* but the material on hand seems to indicate that

the same process of wall formation probably takes place in this parasite.

Simultaneously with the destruction of the parietal tissue of each sporange, the cells separating the two adjacent microsporanges are also destroyed, so that the two microsporanges merge to form a single, large locule. At maturity of the anther only its epidermis and a single hypodermal cell layer, the endothecium, persist. The epidermis remains parenchymatous, while its endothecial cells become thick-walled and devoid of the rod-shaped thickenings that are often encountered in anthers of many angiosperms (Plate 5, fig. 49).

MEGASPORANGE AND MEGAGAMETOPHYTE

The megasporange appears as a small papilla formed by the activity of the cells of the placenta, a condition similar to that obtaining in *Christisonia neilgherrica* Gardn.(53) The epidermal cells of the placenta (Plate 6, fig. 50) contain dense cytoplasm and distinct nuclei, and are usually elongated vertically. These epidermal cells show active anticlinal divisions at various points, and this activity affords a good means of allowing space for the growth of the young megasporanges. In this small papilla (Plate 6, fig. 50) the hypodermal cell of the placenta enlarges and divides periclinally (Plate 6, fig. 51). Its daughter cells enlarge and also divide periclinally (Plate 6, figs. 52 to 54). Division usually takes place first in the lower daughter cell (Plate 6, fig. 52) and then in the upper cell (Plate 6, fig. 53), or the upper daughter cell may not divide at all and three basal cells in a row may arise from the lower daughter cell of the juvenile megasporange (Plate 6, fig. 54) by the formation of two periclinal walls. However, the ultimate product is a uniseriate row of four or more cells (Plate 6, fig. 55), and these cells are covered with an epidermis, which is continuous with that of the placenta. The terminal cell (Plate 6, figs. 54 and 55) in the row usually functions as the megaspore mother cell, while the basal cells constitute the cells to the funiculus.

As the megaspore mother cell elongates and enlarges, and by the time the young megasporange begins to show signs of unequal growth, or even later, an epidermal cell of the megasporange divides periclinally (Plate 6, fig. 54). Division of this epidermal cell is followed by those behind it, such that the nucellus and the single integument become differentiated (Plate 6,

figs. 56 and 57), the former remaining two-layered near the micropyle, and only one-layered farther down the chalaza of the megasporange. Eventually, the integument becomes one-layered in the mature megasporange.

As a result of a quicker growth of the cells on one side, the megasporange bends over towards the opposite side, its apex being at this time directed at an angle of about 45° to the surface of the placenta (Plate 6, fig. 56). By further growth the apex of the nucellus becomes at length directed perpendicularly to the surface of the placenta, and the megasporange assumes its mature anatropous position (Plate 6, fig. 57).

The development of a single archesporial cell in Orobanchaceæ seems to be the rule; an exception is found in *Christisonia neilgherrica* Gardn.,(53) where occasionally two archesporial cells may differentiate, only one of which functions. In other parasitic phanerogams so far studied, many exhibit a unicellular archesporium.(7, 17, 18, 19, 31) Of those parasitic plants developing an archesporium consisting of more than one cell, may be mentioned the following: *Loranthus sphaerocarpus,*(48) *Viscum articulatum* Burm.,(47) *Helosis guyanensis,*(12) *Balanophora elongata* Bl.,(49) *B. phalloides* Jungh.,(32) *Pedicularis foliosa* Linn., *Melampyrum silvaticum* Linn., and *Lathraea squamaria* Linn.(39)

As the anatropous condition of the megasporange is reached, the megaspore mother cell enters synapsis (Plate 6, fig. 56), and divides periclinally (Plate 6, fig. 57). By two successive divisions this megaspore mother cell gives rise to four megaspores in a row (Plate 6, fig. 58), of which the chalazal one becomes functional (Plate 6, fig. 59). The formation of four megaspores has also been noted in *Orobanche*(7) and *Christisonia neilgherrica* Gardn.,(53) of the Orobanchaceæ.

In other phanerogamic parasites there is a great variation in the number of megaspores formed. For example, two megaspores are formed in *Dendrophthora oxycedri,*(54) *Viscum album,*(24) and *Balanophora elongata* Bl.;(17) three megaspores in *Loranthus sphaerocarpus* Bl.,(48) *Arceuthobium oxycedri,*(23) and *Pedicularis verticillata* Linn.;(39) three to four megaspores in *Balanophora globosa* Jungh.,(31) *Rafflesia patma* Bl.,(18) and *Pedicularis verticillata* Linn.;(39) and four megaspores in *Rafflesia hasseltii* T. and P.,(19) *Cytinus hypocistis* Linn.,(7) *Brugmansia zippelii,*(19) *Euphrasia rostkviana* Hayne, *E. odontitis* Linn., *Alectorolophus hirsutus* All., *A. minor* (Ehrh.) Wimm.,

Pedicularis palustris Linn., *P. caespitosa* Sieb., *P. recutita* Linn., *P. tuberosa* Linn., *P. foliosa* Linn., *Melampyrum silvaticum* Linn., *M. pratense* Linn., *Tozzia alpina* Linn., and *Lathraea squamaria* Linn.(39)

In some phanerogamic parasites exhibiting extreme degeneration of their plant organs there is a tendency to shorten the stages involved in the development of their megagametophytes. The formation of primary parietal tissue, for example, from the archesporium, which functions directly as the megaspore mother cell, is almost always absent in Loranthaceæ,(24, 48, 54) Balanophoraceæ,(17, 31, 32) Rafflesiaceæ(7, 18, 19) Scrophulariaceæ,(39) and Orobanchaceæ;(53) in *Arceuthobium oxycedri*(23) and *Balanophora elongata* Bl.(49) the archesporium forms a primary parietal cell. In fact, in some of these parasitic plants the archesporium may even give rise to the embryo sac directly, as in *Lilium;*(15) this is true also of *Helosis guayanensis,*(12) *Rhopalocnemis phalloides* Jungh.,(32) *Balanophora elongata* Bl.,(17, 49, 50) and *Epiphegus virginiana.*(14)

Of the four megaspores formed in *Aeginetia indica* Linn., the chalazal one becomes functional (Plate 6, fig. 59). Degeneration of the three micropylar megaspores does not follow a definite course. It may set in first at the middle megaspores (Plate 6, fig. 58), and then by the micropylar megaspore; or degeneration may start from the latter and proceed upward to the chalaza (Plate 6, fig. 59). At all events, only one of the four remains, and this is usually the uppermost, or chalazal megaspore.

The functional megaspore then enlarges and becomes much vacuolated. Its nucleus starts to divide quite early (Plate 6, fig. 60), and the daughter nuclei migrate to the opposite poles of the enlarged embryo sac, owing, perhaps, to the formation of a large central vacuole (Plate 6, fig. 61). Here the two daughter nuclei divide, and four nuclei (Plate 6, fig. 62) are formed. Another division of these four nuclei completes the normal octonucleate embryo sac often encountered among angiosperms (Plate 6, fig. 63). In Orobanchaceæ similar development of the embryo sac has been reported in *Orobanche* sp.(7) and *Christisonia neilgherrica* Gardn.,(53) and in *Phelipaea coerulea*(7) and *Lathraea squamaria* Linn.,(39) of the Scrophulariaceæ.

The mature embryo sac (Plate 6, fig. 63) is rather long and bottle-shaped, with its largest portion directed towards the mi-

cropyle and the other end often reaching the single-layered integument at the chalazal region of the megasporange. At the micropylar region is located the egg apparatus, which consists of two synergids and a megagamete. The synergid is elongated, more or less pyriform, and possesses a large terminal and a small basal vacuole. It has a distinct nucleus embedded in a rather dense cytoplasm situated near its base. In *Aeginetia*, as well as in other phanerogamic parasites, the "filiform apparatus" of the synergid is absent; in *Santalum album*(38, 45) and *Viscum album*,(43) however, this structure is present. The synergid is ephemeral in character, and seldom persists long (Plate 6, fig. 64; Plate 7, fig. 67) in the embryo sac. It usually shows signs of degeneration at the time the primary endosperm nucleus is dividing (Plate 6, fig. 65) or even earlier (Plate 6, fig. 64; Plate 7, fig. 67). The megagamete is a little larger than either of the synergids, and lies between them. It has a larger basal vacuole (Plate 7, fig. 67) and a larger nucleus embedded in a dense peripheral cytoplasm at its apex.

The polar nuclei (Plate 6, fig. 63) usually lie just above the egg apparatus and between the synergids or above the megagamete. They have large, distinct nucleoli and dense nucleoplasm. Soon these two polar nuclei fuse and a much larger fusion-nucleus results (Plate 6, fig. 64; Plate 7, fig. 67). This fusion-nucleus lies dormant for a long while above the egg apparatus, and it may be oblong, rounded, or oval, exhibiting prominent nucleoli and distinctly dense nucleoplasm.

The antipodals (Plate 6, fig. 63) are situated at the extreme chalazal end of the sac in a socketlike projection, which nearly touches the integument. These antipodals are somewhat persistent and may be arranged in a row (Plate 6, fig. 63; Plate 7, fig. 69) or the upper two may lie side by side below which is the third antipodal (Plate 7, figs. 67 and 70). In rare cases these antipodals may early show signs of degeneration (Plate 6, fig. 63), but usually they persist long after endosperm formation has been under way (Plate 7, figs. 69 and 70). Their cytoplasm is not dense compared with that in the egg apparatus, and their nuclei are much vacuolated and poor in nuclear content. In *Phelipaea coerulea* and *Orobanche* sp.(7) the antipodal cells are ephemeral in nature, while those found in *Lathraea squamaria* Linn.(7) are somewhat persistent, although not as persistent as those in *Aeginetia indica* Linn.

POLLINATION

Being ombrophytic in habit, this parasite flourishes in the thick cane plantation. Floral maturation usually takes place at the time the canes begin to flower or even earlier, at which time the sugar-cane plants have formed an impenetrable or impassable cover around the buñga plants in the fields. It will also be noted that the flowers of this root parasite are never held high from the surface of the ground. Under the conditions given above, the flowers of this parasite are seldom accessible to pollinating insects, except perhaps ants. The chance for insect pollination decreases as the distance from the edge of the cane field is increased, and vice versa. Insect pollination probably does take place, as it cannot be very well eliminated completely, but it may be considered as very insignificant, judging by the results of an examination of flowers at various stages of development.

Long before anthesis, the filaments of the stamens are rather short, and the stigma is held very high. Simultaneously with the maturation of the flowers and usually just before anthesis, these filaments elongate further, and actually push their anthers clear to the stigma (Plate 5, fig. 34), brushing the microspores against it. It will also be noted that dehiscence of the microspores usually takes place long before anthesis, so that if the stigma is examined at the time the corolla has just opened, an abundance of germinating microspores will be seen on the stigma (Plate 4, fig. 32). Microspores that fail to lodge on the stigma may fall on the corolla tube, where they may germinate (Plate 4, fig. 31) on account of the moisture present with the mucilaginous secretions within the corolla tube.

Autogamy is, in the writer's opinion, the most potent factor in the pollination of this parasite; insects play only a minor rôle in the transfer of the microspores from the anthers to the stigma of the same or different flowers. In *Orobanche*(25) the flowers are homogamous, rarely protogynous, bee-pollinated, and sometimes devoid of nectar. Usually the stigmas are held high, but later the stamens grow to the same level with the stigmas and easily pollinate them, a condition which obtains in the buñga flowers.

THE FRUIT

Description.—The fruit of the buñga is a globose or ovoid capsule, which is light yellow when immature, turning ashy gray

or even jet-black at maturity. Its apiculate style is persistent and the whole fruit may be from 1.5 to 2 centimeters long and from 1 to 1.25 centimeters in diameter. When fully mature, it is brittle, and its pericarp easily breaks off, exposing its lamellate placentas on which are borne the yellowish, minute, rather powdery seeds.

Development.—Soon after fertilization the ovary enlarges and the corolla withers. The calyx and the corolla remain as a persistent envelope to the enlarging ovary within them. Of the pistil, the stigma is the first to show signs of darkening, and as the fruit enlarges this darkening proceeds downward to the style. The stigma usually falls off early, while the basal portion of the style together with the enlarging ovary form the major portion of the capsule, the calyx and corolla always remaining as a persistent envelope. At maturity of the capsule, the corolla and the calyx as well as the capsule become dry. The corolla and the calyx break off easily at a slight mechanical pressure from without, and this is true also of the pericarp, so the seeds are easily exposed. Dissemination of the seeds is made more perfect by the detachment of the scape from the mother parasite, and this is effected by the disintegration of the epidermal and cortical cells of the main axis of the scape at the region nearest the ground during drying. This breaking or separation is often hastened by the attacks of termites, which are often abundant in cane fields.

The ovary wall of the pistil is at first very thin, and consists mostly of thin parenchymatous ground tissue delimited by distinct epidermal layers and provided with an abundance of starch grains. After fertilization and simultaneously with the maturation of the capsule, its pericarp becomes highly differentiated into two distinct regions. The cells of the outer half of the pericarp (Plate 5, fig. 40) remain parenchymatous. Later, the starch grains found in them disappear, and their walls become mucilaginous and ultimately disintegrate. On the other hand, the inner half of the pericarp possesses cells that become thick-walled and are highly lignified. This inner lignified half of the pericarp persists as the covering to the mature capsule. The mucilaginous character of the young capsule is partly due to the outer half of its pericarp and partly to the presence of the mucilage secreted by the glandular hairs on the inner surface of the corolla. At maturity of the capsule the mucilage around it gets

dry and the lignified inner tissue of the pericarp as well as the calyx and the corolla act as a protective wall to the fruit.

THE SEED

Description.—The small, yellowish, albuminous seed, which is beautifully illustrated macroscopically by Kusano,(28) is irregularly subglobose and is produced in abundance. Its testa consists of a layer of large, often yellowish cells with conspicuous reticulate thickenings. The cells of the testa are somewhat isodiametric, much more developed at the chalazal end as well as on the sides of the seed, but poorly developed in the micropylar region (Plate 7, fig. 82). Inclosed by the single-layered testa is the endosperm, consisting of large isodiametric cells filled with starch grains and oil. If the seeds are immersed in concentrated chloral hydrate overnight and then pressed between a cover glass and a glass slide with a drop of Sudan III, numerous red fat globules will be seen oozing from the seeds. The cellulose inner and radial walls of the endosperm are thin, while their outer tangential walls are coated with a heavy, rather thin, cutinized layer, which is hardly soluble in concentrated sulphuric acid. Inclosed by this endosperm is a small, oblong or rounded embryo, consisting of one or often two rows of cells surrounded by a distinct epidermis. The cells of the embryo are also isodiametric and parenchymatous, and in them are stored starch grains and oil. This embryo is simple in that it possesses no distinct plumule, radicle, or cotyledons. Its narrow end is directed towards the micropylar end of the seed. Kusano(29) also observed similar peculiarities of the seeds after placing them for some time in concentrated chloral hydrate and examining them in toto.

Among numerous species of Orobanchaceæ, Caspary(10) has observed that the mature seeds of *Orobanche cruenta* Bert., *O. procera* Koch., *O. pruinosa* Lapeyr., *O. epithymum* DC., *O. galli* Duby, *O. rubens* Willd., *O. lucorum* A. Br., *O. minor* Sutt., *O. amethystea* Thuill., *O. cumana* Wall., *Phelipaea coerulea* C. A. M., *P. arenaria* Walp., and *P. ramosa* C. A. M. are all egg-shaped, with one-layered testæ from the chalazal end to the middle and three- to four-layered ones on the micropylar end. *Orobanche* has porous walls on the testa, the pores being numerous, small, and rounded in *Orobanche cruenta, procera, pruinosa, epithymum, galli, rubens, lucorum, minor, amethystea,* and *cumana.* In *Phelipaea* the thickenings of the walls of the testa

are reticulate, similar to those obtaining in *Aeginetia indica* Linn. Of the thirteen species examined by this investigator, the endosperm is egg-shaped and consists of from nineteen to twenty-one cells in longitudinal section, and these are filled with oil globules. At the micropylar region about three-eighths of its length is occupied by the embryo, which is ovate-elliptic and consists of thirteen to fifteen cells in longitudinal section, and is four to five cells wide; all the cells contain oil. The embryo is devoid of radicle, cotyledons, and other accessory organs.

The seeds of the buñga are produced in abundance, but many of them show the absence of embryos and are, therefore, sterile. The seeds also exhibit variations in size, and the sterile ones are usually smaller than the fertile plump seeds. In ovaries where numerous megasporanges are formed, it is to be expected that not all of these would be fertilized, and this fact should be kept in mind in considering the development of sterile seeds. Several other factors known to cause sterility in seeds have not been ascertained, but it is sufficient to know that a single seed is enough to cause trouble in a hill of canes.

Endosperm.—The endosperm of this parasite is of the cellular type. Among the Orobanchaceæ a type of endosperm similar to the one reported here for the buñga has been described in *Phelipaea coerulea* and *Orobanche* sp.,(7) *O. hederae,*(40) *Christisonia neilgherrica* Gardn., and *Ch. subacaulis* Gardn.,(53) and perhaps *Orobanche cumana* and *O. ramosa.*(40) *Cuscuta*(15) and *Rafflesia patma* Bl.(19) show a nuclear type of endosperm, a deviation from the great majority of the parasitic phanerogams so far studied. In *Helosis guyanensis*(12) the single polar nucleus gives rise to the pseudoendosperm.

The primary endosperm nucleus very early divides (Plate 6, fig. 65) horizontally, and cytokinesis takes place between the two daughter nuclei (Plate 6, fig. 66). One of the daughter nuclei migrates into the small, cylindrical chalazal prolongation of the embryo sac, where it remains dormant (Plate 7, figs. 69 and 70). The lower daughter nucleus remains at the vicinity of the zygote, and this nucleus gives rise to the cellular endosperm found in the mature seed.

The first division of the nucleus of the lower endosperm cell seems to be vertical, and by repeated horizontal walls (Plate 7, fig. 68) vertical rows of endosperm cells result (Plate 7, figs. 69 and 70). During the development of this cellular endosperm, the embryo sac enlarges considerably at its micropylar end

where the endosperm remains one-layered (Plate 7, fig. 81), and widens rapidly upward where several layers of endosperm cells are produced (Plate 7, figs. 79 and 80). The development of the cellular endosperm from the lower endosperm cell pushes the upper endosperm cell (Plate 7, figs. 69 and 70), clear to the persistent antipodal cells at the chalazal end of the seed. This upper chalazal endosperm cell (Plate 7, fig. 70) may be homologous with the chalazal haustorium often encountered in other species of the Orobanchaceæ.(7)

The micropylar cells of the cellular endosperm elongate considerably and form haustoriumlike processes on the sides of the zygote (Plate 7, fig. 70). It is to be noted that although these micropylar endosperm cells have elongated longitudinally, they do not possess thick cytoplasm and distinctly amœboid nuclei, so constant a feature in haustorial cells reported in many species of the Orobanchaceæ. They seem to be degenerated haustorial cells (Plate 7, fig. 81), becoming nonfunctional in the species under discussion. Vertical divisions take place mostly among the endosperm cells (Plate 7, figs. 78 to 80) above these elongated, micropylar, haustorial cells, so that the endosperm becomes club-shaped in appearance, with its small, elongated, tapering end directed towards the micropyle, and its enlarged portion towards the chalaza. Of the endosperm cells thus formed in the developing seed, the peripheral ones are the largest, and are persistent (Plate 7, figs. 79 and 80) in the mature seed (Plate 7, fig. 82). Starch and oil are abundant in these endosperm cells.

Bernard(7) has observed that the primary endosperm nucleus in *Lathraea squamaria* Linn. divides into two, a wall separating the primary endosperm cell into two equal parts, the chalazal cell nucleus dividing and the cell enlarging so that it becomes binucleate. The micropylar cell forms the cellular endosperm, its micropylar cells becoming elongated and considerably enlarged with large nuclei. The enlarged binucleate chalazal endosperm cell elongates into the chalazal nucellus and funiculus, and possesses dense cytoplasm around its nuclei. In *Orobanche* and *Phelipaea* the chalazal daughter endosperm cell elongates in the direction of the funiculus and forms a conducting element, typical and homologous with that found in *Lathraea*. The superior endosperm cell becomes cellular.

As the buñga seed matures, the embryo gradually absorbs the endosperm tissue so that nothing of this cellular endosperm remains except its outermost, peripheral layer (Plate 7, fig. 82).

Embryo.—The zygote does not undergo division soon after fertilization (Plate 6, figs. 65 and 66; Plate 7, figs. 67 and 68), but remains dormant until after endosperm formation has long been underway (Plate 7, fig. 70). Soon after the cellular endosperm has been formed from the lower endosperm cell, the zygote elongates considerably, pushing itself between the endosperm cells (Plate 7, fig. 70). The zygote then seems to have undergone several transverse divisions (Plate 7, fig. 81), but the writer was not able to follow very closely the sequence of division of the zygote as the material on hand was very scant. It seems probable that the apical cell gives rise to the proembryo (Plate 7, fig. 71), while the basal cell forms the suspensor, which degenerates quite early (Plate 7, figs. 72 to 78). Division of the cells of the zygote is perhaps variable. However, a globose embryo devoid of cotyledons, radicle, and plumule, even of their rudiments, is developed in the mature seed (Plate 7, fig. 82).

Nucellus.—The nucellus of the megasporange undergoes enlargement soon after fertilization. Its cells are isodiametric, vacuolated, and filled with an abundance of starch grains, and their nuclei are small. During later development of the seed the stored starch grains in the nucellus disappear and are absorbed by the developing endosperm within. The enlarging endosperm then presses the nucellar cells against the massive testa, and this nucellus disappears in the mature seed.

Coat or testa.—Before fertilization the single integument has two rows of cells near the micropylar end of the nucellus (Plate 6, figs. 56 and 57) and only a single layer at the chalaza. Its outer layer of cells is continuous with the epidermis of the funiculus and placenta. As the seed approaches maturity, this coat becomes one-layered throughout. These cells of the coat at first form one of the tissues utilized for the storage of starch by the developing young seed, but after the endosperm is fully developed, this function is relegated to it, and starch grains disappear from the seed coat.

Long before maturity of the seed the single-layered testa becomes lignified, and its cells develop the characteristic reticulate thickenings on their walls. This beautiful and thick reticulation of the cells of the single-layered coat of the seed of this parasite is carefully illustrated by Kusano.(28) These lignified and reticulated testa cells render the seed hard to section with the microtome. In other words, the mature seed is protected externally by the lignified and reticulated cells of the seed coat,

or testa, and internally by the cutinized layer surrounding the tangential walls of the endosperm. Neither the seed coat nor the endosperm is well developed at the micropylar end of the seed, the former being sometimes absent or feebly developed, while the latter possesses no distinct cutinized layer on the outer walls of its cells.

SUMMARY

The anatomy and morphology of the vegetative and the reproductive organs of *Aeginetia indica* Linn., an important orobanchaceous root parasite on the sugar-cane plant in the Philippines, are herein reported.

An important factor to be considered as influencing its whole vegetative structure is its parasitism, and this finds expression in the retrogressive direction so as to suit the changed habit and conditions of the life of this parasite. Chief among its peculiarities, which may be taken as the outcome of its parasitic life, are (*a*) the branching and anastomosing root system; (*b*) the rhizomelike character of the roots, which are devoid of root hairs and root caps; (*c*) the formation of tubercles from which haustoria, young lateral roots, and scapes are produced—these tubercles serve as storehouses for the nutrition of the plant; (*d*) the modified anatomical structure of the cylinder of the root and scapes in which the xylem has become reduced and the phloëm correspondingly developed; (*e*) the correlation of the reduction of its conducting system with the absence of foliar leaves replaced by scales; (*f*) the complete absence of chloropyll; and (*g*) its great power of storing large amounts of starch in all its aërial as well as underground organs, which often pass out into the soil at the death of the plant.

The anatomical structure of the root does not preclude the possibility of water absorption taking place from the soil.

The root and the scape have endogenous origin, and the writer confirmed the findings of Kusano.(28) On ratoon canes secondary roots may directly form scapes or reproductive organs laterally or terminally, due perhaps to the stimulating action of the fire after the canes are harvested.

The aërial organs, except the scale leaves, are devoid of natural openings or stomata. The absence of natural covering to help prevent rapid loss of water from its organs is evident; this condition is responsible for its becoming an ombrophyte, and its resulting inability to withstand extreme exposure to the sun.

The development of its microspores is normal, and in all probability these microspores become separated by active furrowing of the cytoplasm through the formation of wedges derived from a special wall of the microspores similar to that obtaining in *Lathraea.*(20) The mature microspore is binucleate.

The megasporange arises as a papilla from the placenta, and very early becomes anatropous. It is unitegumentary, and a single apical and terminal megaspore mother cell is differentiated on its nucellus. The mother cell develops normally into a conventional seven-celled megagametophyte.

Pollination is largely autogamous, although insects may play a limited rôle in the transfer of its microspores from the anthers to the stigma of the same or different flowers.

The fruit is a dry capsule, containing numerous minute, yellowish, albuminous seeds. Its endosperm is of the cellular type, exhibiting vestigial formation of haustorial cells. The seed coat consists of one-layered, lignified, reticulately sculptured cells, while its embryo is composed of a globose, few-celled structure, devoid of cotyledons, radicle, and plumule. Covering the endosperm is a highly cutinized layer.

From the foregoing anatomical and morphological features of the buñga the following generalizations may be drawn: (*a*) Infestation of canes must be attributed largely to seeds left by previous buñga crops, but other avenues of infection may be found; (*b*) the high drying power of its organs is due to the absence of any natural covering designed to limit the escape of moisture once it is exposed to air; (*c*) the darkening of the parasite on exposure to air is due to the presence of tannin; (*d*) the seed is protected and is provided with an abundance of stored food (mainly starch and oil) in its endosperm and in its embryo, hence a very specialized form of attack has to be adopted to eradicate the parasite; (*e*) ratooning canes infested with the parasite is very favorable to the perennial growth of buñga; and (*f*) the effort to eradicate it must be centered on preventing seedage and the germination of the seeds left by previous buñga crops.

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ILLUSTRATIONS

Plate 1. Aeginetia indica Linnæus

Fig. 1. Transverse section of a young root; *co*, cortex; *ep*, epidermis; *p ph*, primary phloëm; × 240.

2. Transverse section of the central cylinder of an older root showing differentiation of the triarch primary bundles; *cc*, companion cell; *px*, primary xylem; *si t*, sieve tube; *co*, cortex; × 156.

3. Portion of a transverse section of a primary tubercle with a young primary root cut longitudinally, emerging from the former; *co*, cortex of the tubercle; × 156.

4. Portion of a vascular bundle from a transverse section of a mature root (taken from fig. 7); *ca c*, cambial cell; *px*, primary xylem; *scl r*, sclerenchymatous ring; *si t*, sieve tube; *tr*, tracheid; × 156.

5. Diagram of a section of a primary tubercle showing the cortex (*co*), central cylinder or stele (*ste*), primary root primordia (*pr*), and vascular bundles (*vb*); × 18.

6. Diagram to show relationship between the host root (*hr*) and the parasite; *co*, cortex of tubercle; *ste*, stele of tubercle; *h*, haustorium; × 18.

7. Diagram of a transverse section of a mature root; *co*, cortex; *ep*, epidermis; *px*, primary xylem; *scl r*, sclerenchymatous ring; *s ph*, secondary phloëm; *sx*, secondary xylem; × 18.

8. Embryogenic cells of a primary root primordium (shaded cells); *co*, cortex of tubercle; × 156.

9. Portion of a transverse section of the scale leaf; *l ep*, lower epidermis; *u ep*, upper epidermis; *vb*, vascular bundle; × 74.

Plate 2. Aeginetia indica Linnæus

Fig. 10. Transverse section of a secondary root showing early formation of secondary tubercle; *co*, cortex; *ep*, epidermis; *p ph*, primary phloëm; *px*, primary xylem; × 38.

11. Portion of a transverse section of a young primary tubercle showing vascular bundles cut transversely; × 156.

12. Longitudinal section of a haustorium (taken from Plate 1, fig. 6); *co*, cortex of tubercle; *en*, endodermis of host root; *tr*, tracheid to the haustorium; *xy*, xylem vessel of the host root; × 156.

13. Showing epidermal cells of the haustorium in contact with the cortical cells of the host root; *ep*, epidermal cells of the haustorium; *hr*, host root; × 156.

FIG. 14. Diagram of a transverse section of a tubercle showing a scape arising from it; *co*, cortex; *ep*, epidermis; *fp*, floral primordium; *sl*, scale leaves; *tub*, tubercle; × 18.

15. Diagram of a transverse section of the host root with a tubercle attached to it; *co*, cortex; *tub*, tubercle; *h*, haustorium; *hr*, host root; *ste*, stele of the host root; × 18.

16. Portion of a transverse section of the main axis of the scape showing a single vascular bundle; *co*, cortex; *bs*, bundle sheath; *ep*, epidermis; *ph*, phloëm; *pi*, pith; *tr*, tracheids; × 156.

PLATE 3. AEGINETIA INDICA LINNÆUS

FIG. 17. Diagram of a portion of a transverse section of the main axis of the scape far from the tubercle showing positions of the vascular bundles; *co*, cortex; *ep*, epidermis; *bs*, bundle sheath; *vb*, vascular bundle; × 18.

18. Portion of a single vascular bundle taken at *A* from fig. 17; *si t*, sieve tube; *tr*, tracheid; × 156.

19. Portion of a single vascular bundle taken at *B* from fig. 17; *si t*, sieve tube; *tr*, tracheid; × 156.

20. A diagram of a transverse section of the scape near its apex to show positions of the scale leaves and the pedicels; *m ax*, main axis; *ped*, pedicel; *sl*, scale leaves; × 18.

21. Diagram of a transverse section of a young pedicel showing positions of procambial strands (*ps*); *co*, cortex; *ep*, epidermis; × 18.

22. Portion of a transverse section of the calyx; *i ep*, inner epidermis; *vb*, vascular bundle; × 156.

23. Portion of a transverse section of the corolla; *i ep*, inner epidermis; *o ep*, outer epidermis; *vb*, vascular bundle; × 156.

24. Diagram of a transverse section of a young flower showing the relative positions of its parts; *ca*, calyx; *cor*, corolla; *l*, locule; *ov*, ovary; *p*, placenta; *st*, stamen; × 18.

25. Diagram of a transverse section of the spur of the stamen; *ep*, epidermis; *vb*, vascular bundle; × 18.

26. Diagram of a transverse section of a filament; *ep*, epidermis; *gh*, glandular hairs; *vb*, vascular bundle; × 18.

27. Diagram of a transverse section of the style; *ep*, epidermis; *mc*, mucilage cells; *ho*, hollow; *vb*, vascular bundle; × 18.

PLATE 4. AEGINETIA INDICA LINNÆUS

FIG. 28. Portion of a transverse section of an old root; *co*, cortex; *ph*, phloëm; *px*, primary xylem; *sx*, secondary xylem; *scl r*, sclerenchymatous ring; × 93.

29. A portion of a transverse section of a mature pedicel; *co*, cortex; *ph*, phloëm; *x*, xylem; *pi*, pith; × 93.

30. Longitudinal section of a root showing its apex; × 93.

31. Showing germinating microspores on the inner surface of the corolla tube; × 93.

32. Portion of a longitudinal section of the stigma showing microspores germinating on its papillate cells; × 93.

FIG. 33. A portion of a transverse section of the main axis of the scape near its attachment to the tubercle; *co*, cortex; *vb*, vascular bundle; *pi*, pith; × 62.

PLATE 5. AEGINETIA INDICA LINNÆUS

FIG. 34. A sketch of a mature flower with half of its calyx and corolla removed so as to expose its other organs; *ca*, calyx; *cor t*, corolla tube; *ov*, ovary; *ped*, pedicel; *st*, stamen; *sti*, stigma; *sty*, style; × 0.66.

35. A diagram of a longitudinal section of a young scape showing scale leaves (*sl*) at the axils of which arise the floral primordium (*fp*); × 18.

36. Longitudinal section of a young floral primordium showing calyx (*ca*) and beginnings of the petals (*pe*); × 18.

37. An older flower showing calyx (*ca*), petals (*pe*), and stamens already differentiated (*st*); × 18.

38. Showing young hairs from the inner epidermal cells of the calyx; × 360.

39. Mature glandular hairs from the inner epidermis of the calyx; × 360.

40. Portion of transverse section of the ovary wall, or pericarp, of a nearly mature capsule showing its lignified inner half and a disintegrating, mucilaginous outer half; × 66.

41. A diagram of a transverse section of an anterior anther; *sp t*, sporogenous tissue; *vb*, vascular bundle; × 38.

42. Showing the sporogenous tissue (*sp t*) and tapetum (*t*) with the parietal tissue (*pt*) (taken from fig. 41); *ep*, epidermis; × 360.

43. Portion of a longitudinal section of an older anther showing the mass of microspore mother cells (*mi mc*), tapetum (*t*), and thin parietal tissue (*pt*); *ep*, epidermis; × 360.

44. Microspore mother cell in open spireme; × 660.

45. Tetrads still in a special mucilaginous coat; microspore mother cell wall already gone; × 660.

46. Transverse section of the ovary showing the four placentas (*p*); *l*, locule; × 18.

47. Tetrads without special mucilaginous coat; × 660.

48. Microspore just before dehiscence showing a large, rounded pollen tube nucleus (*ptn*), or vegetative nucleus, and a lenticular generative nucleus (*gn*); × 660.

49. Portion of a longitudinal section of a mature anther showing epidermis (*ep*), endothecial layer (*endt*), and remains of the parietal tissue (*pt*); note the size of the microspores (*mi*); × 240.

PLATE 6. AEGINETIA INDICA LINNÆUS

FIG. 50. Showing enlargement of a hypodermal cell of the placenta and anticlinical division of its epidermal cell (*ep*); × 360.

51. First anticlinal division of a hypodermal cell of the placenta; × 360.

FIG. 52. Periclinal division of the lower daughter nucleus of the placental hypodermal cell; × 360.

53. Upper daughter cell dividing; × 360.

54. Young megasporange with an elongated, terminal megaspore mother cell (*mmc*); three lower cells arising from the lower daughter cell of the hypodermal initial; note the beginnings of the integument (*in*); × 360.

55. An older megasporange showing the megaspore mother cell; note unilateral growth; × 360.

56. A megasporange showing its terminal megaspore mother cell in open spireme; integument (*in*) fully differentiated as well as the nucellus; *mic*, micropyle; *f*, funiculus; × 360.

57. A still older megasporange with megaspore mother cell in metaphase stage (heterotypic); *in*, integument; *f*, funiculus; *n*, nucellus; × 360.

58. Tetrads; two middle megaspores showing degeneration, chalazal one enlarging; × 360.

59. Showing chalazal megaspore enlarged; three micropylar megaspores degenerated; × 360.

60. First division of the nucleus of the functional megaspore; × 660.

61. Binucleate embryo sac showing polarity; × 660.

62. Quadrinucleate embryo sac; × 660.

63. Mature embryo sac showing contents; antipodals (*an*) showing early degeneration; polar nuclei (*pn*) still unfused near the egg apparatus; *me*, megagamete; *sy*, synergid; × 660.

64. Showing early degeneration of the synergid (*sy*); *fn*, fusion nucleus; *me*, megagamete; × 660.

65. Showing the first division of the primary endosperm nucleus and degeneration of the synergid (*sy*); zygote (*zy*) dormant; × 660.

66. Daughter cells from the first division of the primary endosperm cell; zygote (*zy*) still undivided and synergid (*sy*) degenerating; *l end c*, lower endosperm cell; *u end c*, upper endosperm cell; × 660.

PLATE 7. AEGINETIA INDICA LINNÆUS

FIG. 67. Embryo sac showing degenerated synergid (*sy*) and antipodals (*an*); *fn*, fusion nucleus; *me*, megagamete; × 660.

68. Showing the second division of the daughter endosperm nuclei; wall not cut across; *zy*, zygote; *sy*, synergid; × 660.

69. Chalazal portion of the endosperm showing antipodals (*an*) and the upper endosperm cell (*u end c*); × 660.

70. Embryo sac with cellular endosperm, micropylar cells of which have enlarged and elongated; upper endosperm cell (*u end c*) remaining inactive and much elongated; antipodal nuclei (*an*) persisting and zygote (*zy*) elongated considerably; × 660.

FIGS. 71 to 78. Proembryos with degenerated suspensors (*sus*); × 660.

79 and 80. Transverse sections of the endosperm (*end*) and embryo (*em*); × 660.

FIG. 81. Longitudinal section of an older endosperm (*end*) showing the enlarged micropylar cells; note the embryo (*em*) with darkened nuclei; × 360.

82. Longitudinal section of a nearly mature seed (seed coat not included); *end*, endosperm; *cl*, cutinized layer; *em*, embryo; × 273.

PLATE 8. AEGINETIA INDICA LINNÆUS

FIG. 83. Portion of a transverse section of a young root showing early beginning of a branch root (cells with darkened nuclei); *co*, cortex; *pi*, pith; *p ph*, primary phloëm; × 240.

84. Portion of a transverse section of an older root showing the primordium of the branch root within the cortical tissue of the mother root; × 240.

85. Transverse section of a secondary root showing more compact and active cortical cells on its lower side; note the spongy character of the cortical cells on the opposite side; *ep*, epidermis; *co*, cortex; *p ph*, primary phloëm; *pi*, pith; × 240.

86. Further differentiation of the lower cortical cells of a secondary root in the formation of the secondary tubercle; note the vascular bundles (*vb*); × 240.

87. Portion of a section of a primary tubercle showing primordium of a scape still within the thin cortical tissue (*co*); *sl*, scale leaf rudiment; × 75.

88. An older scape emerging from the primary tubercle with young lateral scale leaf (*sl*); *vb*, vascular bundle; × 75.

89. Diagram of a section of a primary tubercle showing young scape emerging from its lateral side; axillary pedicel (*ped*) already differentiated; *m ax*, main axis to the scape; *sl*, scale leaves; × 18.

PLATE 9. AEGINETIA INDICA LINNÆUS

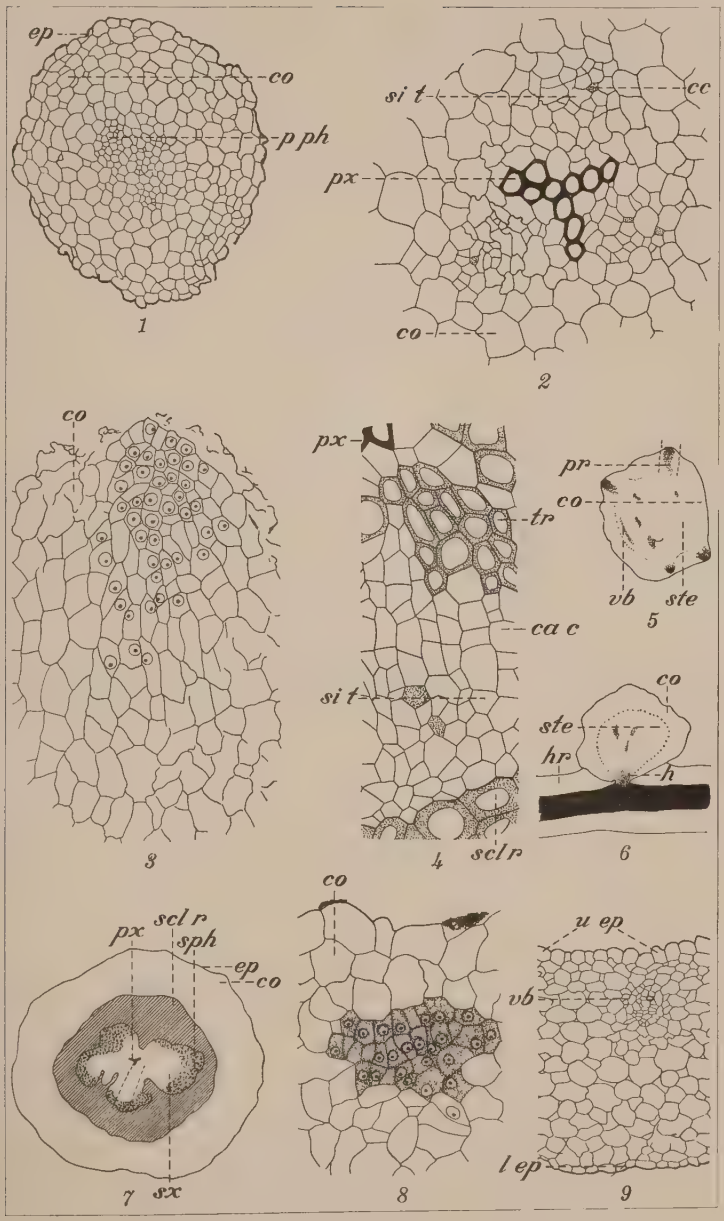
FIG. 90. Ratoon canes (POJ 2878) dug April 28, 1934, with fresh parasite producing young scapes. Reduced to about one-half its natural size.

91. *A*, a portion of a root of the parasite developing scapes (*sc*) at its side and injured apex without forming tubercles, × 4. *B*, tubercle (*tub*) forming a scape (*sc*); (*br*) branch roots, × 2.

PLATE 10. AEGINETIA INDICA LINNÆUS

FIG. 92. The parasite in bloom on ratoon canes (POJ 2878) June 14, 1934, about two and one-half months after the canes had been harvested. Reduced to about one-half its natural size.

93. The growth of the parasite (*pa*) one month after the seedling (*hs*) cane (POJ 2878) had been inoculated with fresh viable seeds. The specimen was preserved in 10 per cent formalin before it was photographed. Reduced to about one-half its natural size.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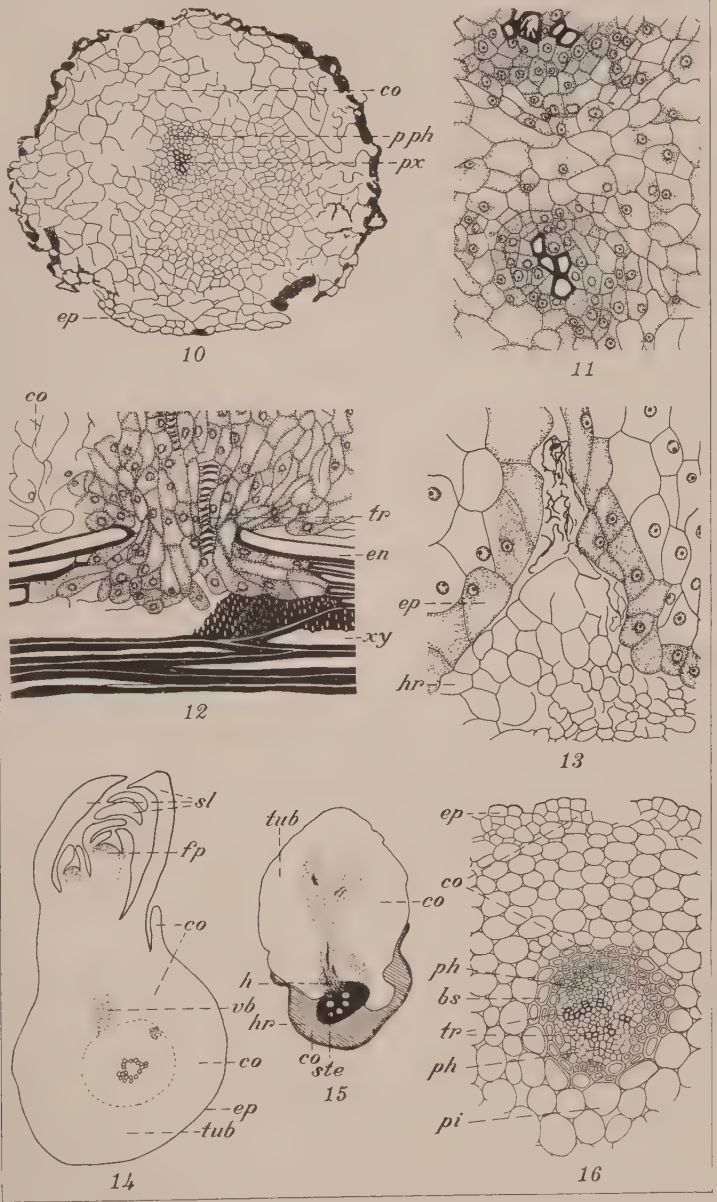
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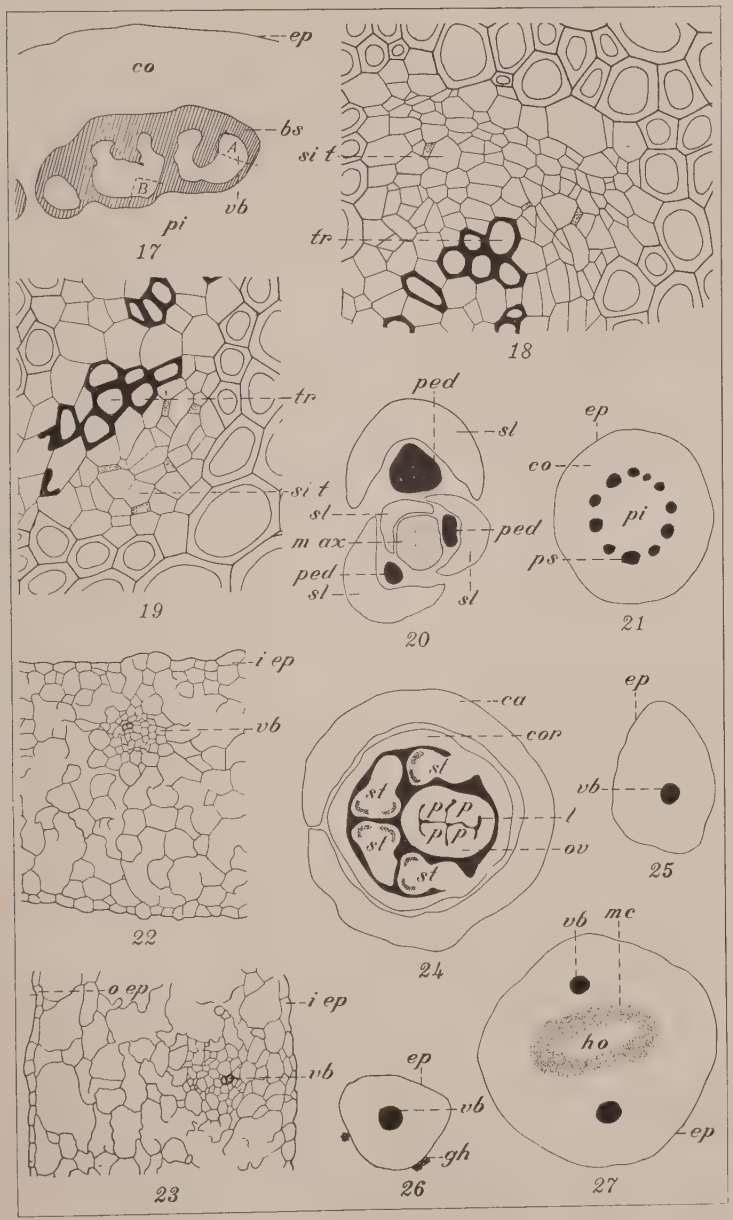
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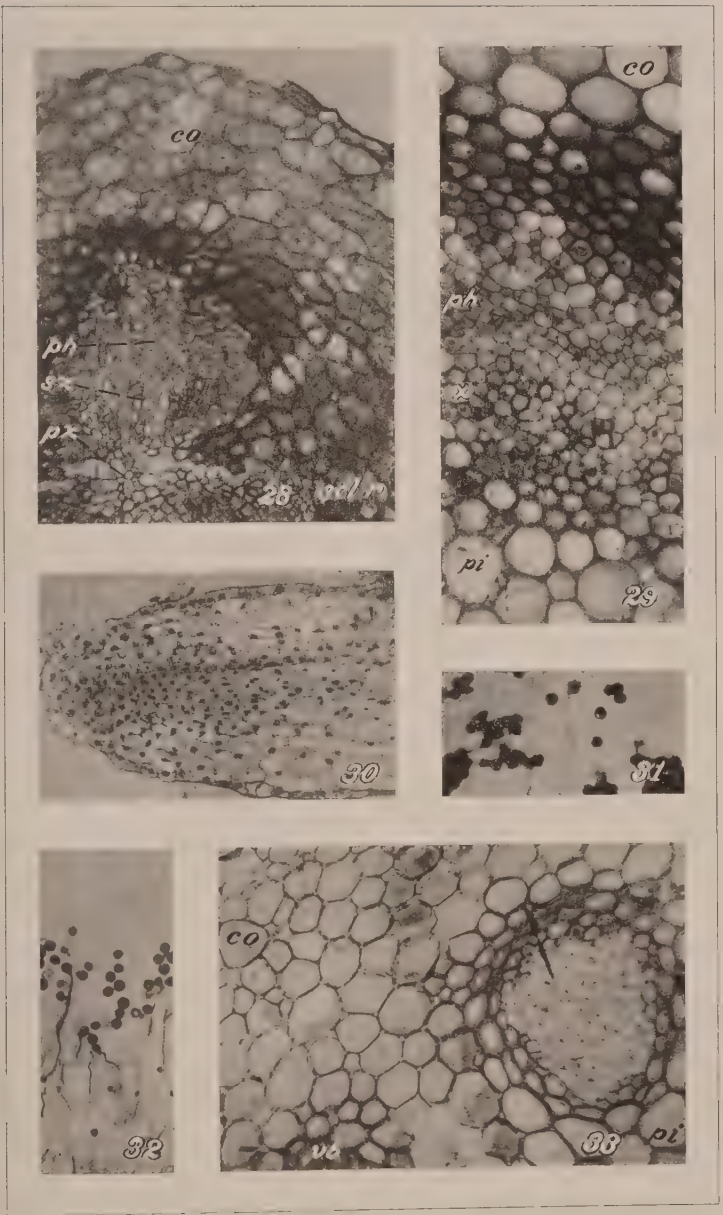

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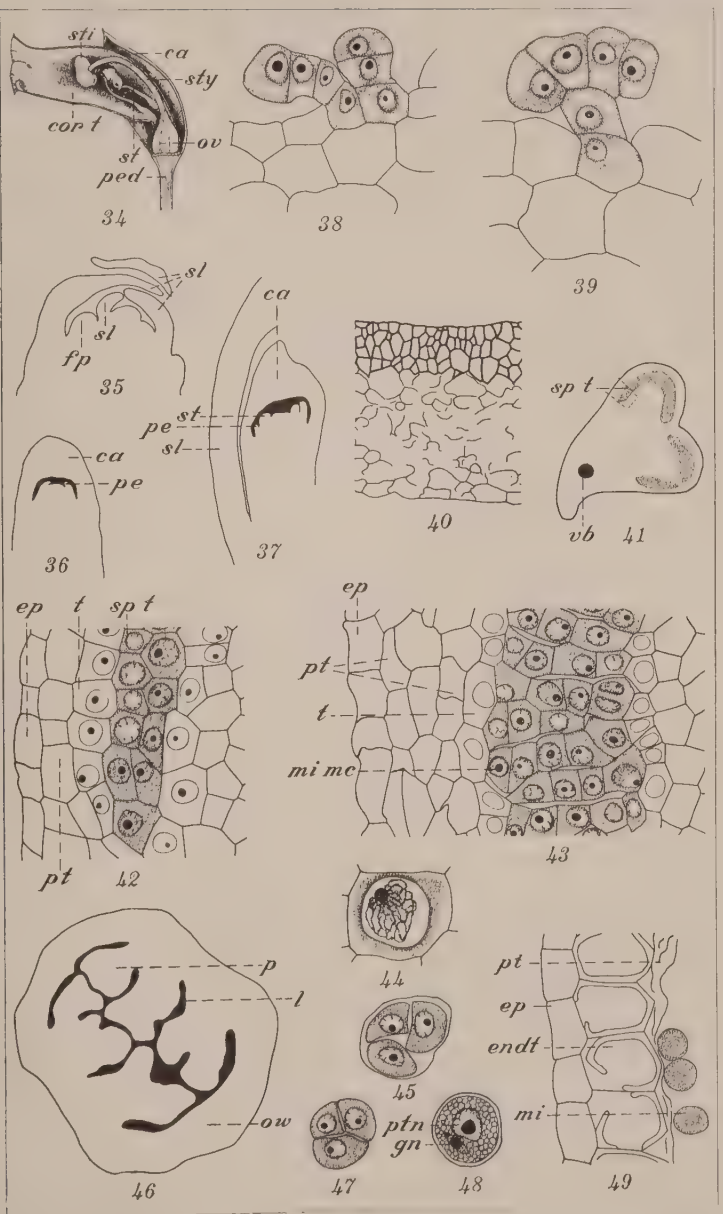
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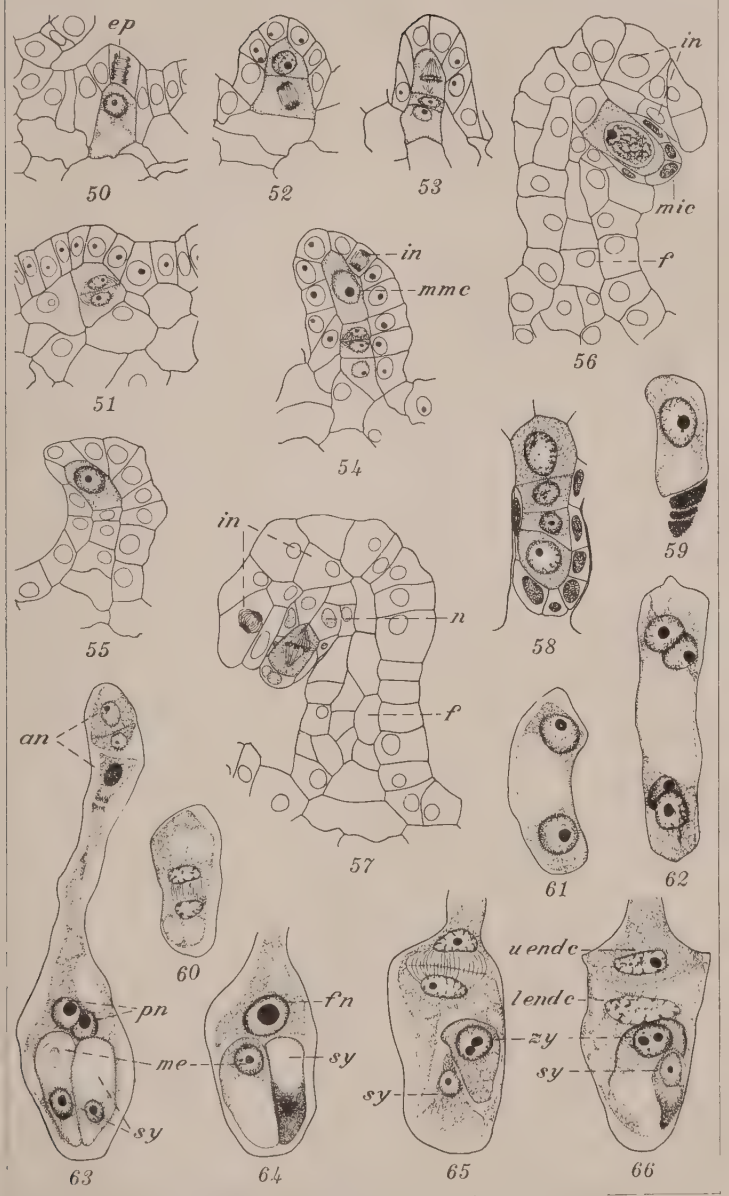
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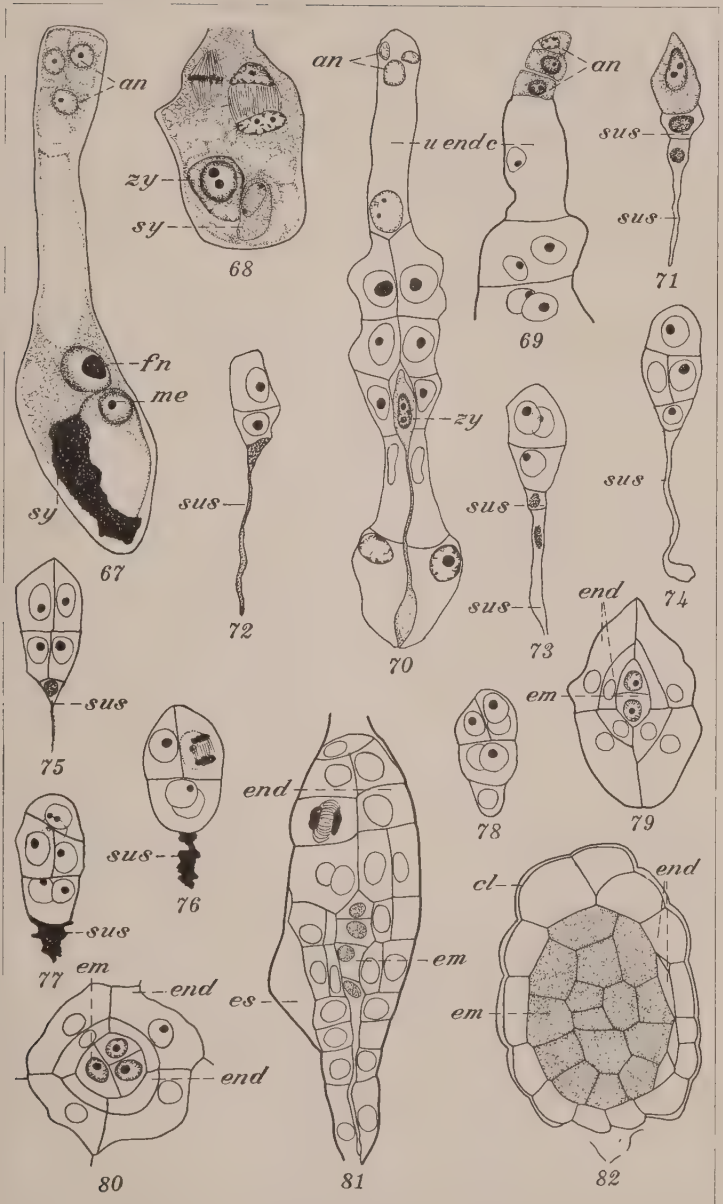
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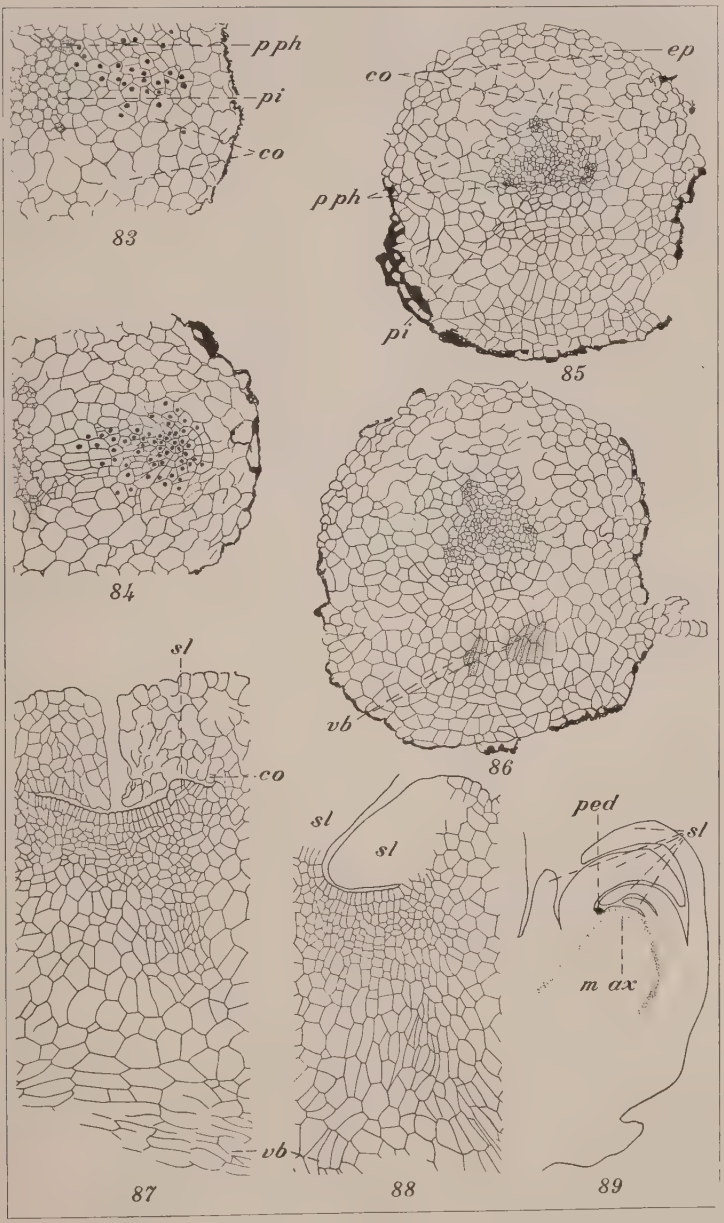
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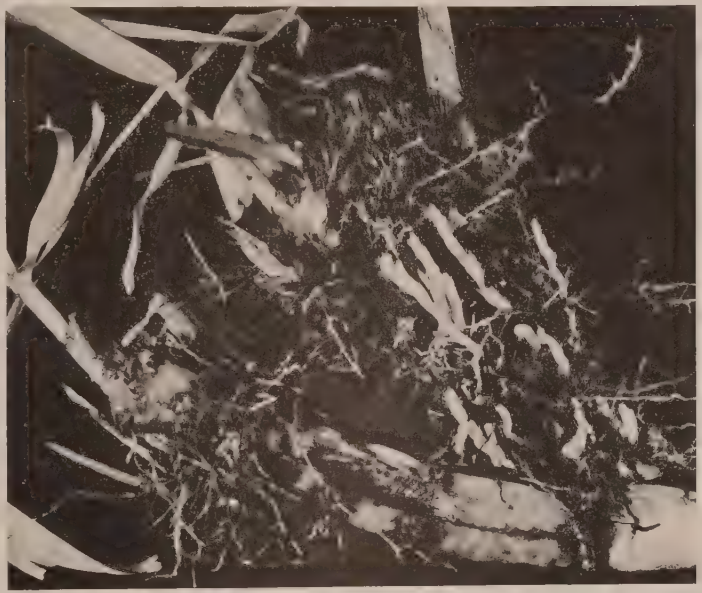
PLATE 8.



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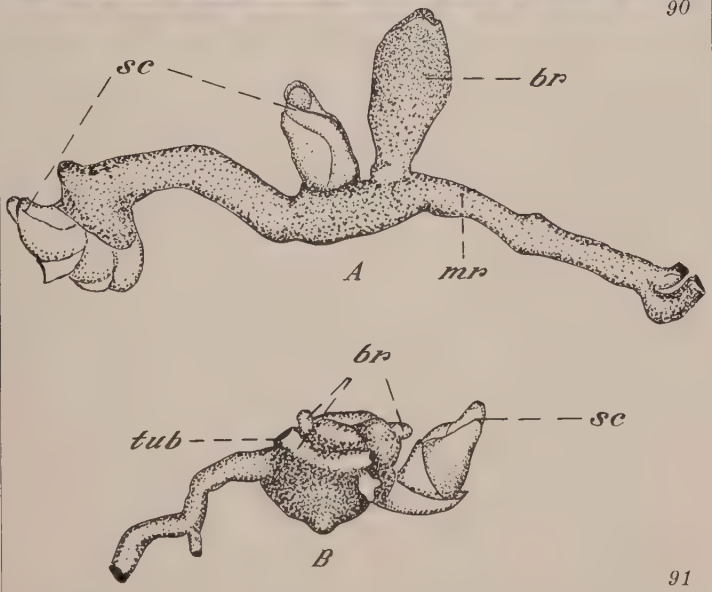

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PLATE 9.

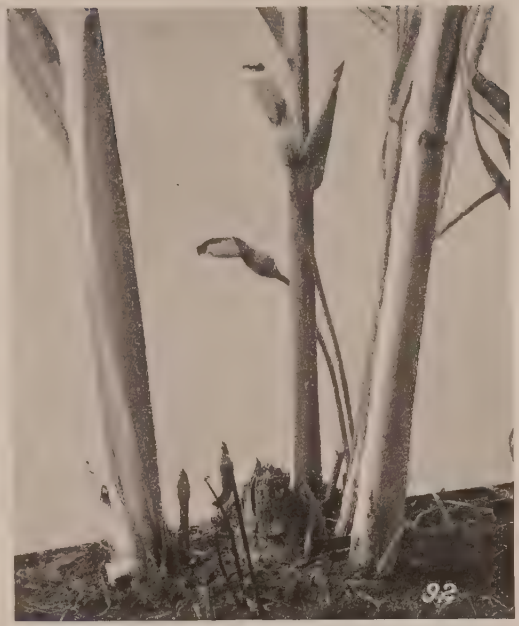

PLATE 10.

NEW OR NOTEWORTHY PHILIPPINE ORCHIDS, V

By OAKES AMES

Professor of Botany in Harvard University

and

EDUARDO QUISUMBING

Curator, Philippine National Herbarium, Bureau of Science, Manila

TEN PLATES

The present paper is essentially similar to its predecessors.[1] It consists of descriptions of one new species and four new varieties. Four previously described species, *Dendrobium cerinum*, *Bulbophyllum Lobbii*, *Renanthera elongata*, and *Trichoglottis Guibertii*, are for the first time credited to the Philippine Islands with certainty. *Dendrobium anosmum* var. *Dearei* and *Dendrobium anosmum* var. *Huttonii*, which were known only from their original descriptions, were recently rediscovered. *Dendrobium Schuetzei*, which is known only from Agusan and Surigao Provinces, Mindanao, is for the first time illustrated in color and redescribed. All the descriptions in the text have been prepared from living specimens, and all the illustrations were made by Mr. Pedro Ramos, draftsman of the National Museum Division, Bureau of Science. All the types of the new species and varieties have been deposited in the Philippine National Herbarium, Bureau of Science, formerly called Herbarium of the Bureau of Science, with isotypes in the herbarium of the senior author. Available isotypes will be distributed to the herbarium of the New York Botanical Garden and to other herbaria.

Genus DENDROBIUM Swartz

DENDROBIUM ANOSMUM Lindl. var. DEAREI (Rolfe) Ames and Quis. comb. nov. **Plate 1, fig. 1; Plate 5.**

Dendrobium superbum Reichb. f. var. *Dearei* ROLFE in Lindenia 6 (1891) 52, *sub t. 264;* ROLFE in Orch. Rev. 14 (1906) 177, *fig. 22;* AMES, Orch. 2 (1908) 187.

[1] Philip. Journ. Sci. 44 (1931) 369–383, 16 pls.; 47 (1932) 197–220, 29 pls.; 49 (1932) 483–504, 28 pls.; 52 (1933) 443–473, 17 pls.

? *Dendrobium macranthum* Hook. var. *album* NAVES, Novis. App. (1882) 233.

La variété DEAREI *a les fleurs du blanc le plus pur, avec les segments très pointus.*

In habit similar to the species, but the stems are shorter and more slender. The flowers are pure white, except the naphthalene yellow throat of the lip, slightly fragrant, 8.5 to 9.5 cm across. The sepals lanceolate, 5.2 to 5.3 cm long, 1.5 to 1.6 cm wide, the dorsal acute, the laterals acuminate and forming a mentum or short spur which is pale greenish. Petals elliptic, acute, about 5 cm long, 3.2 cm wide.

LUZON, Manila, Mrs. Remedios C. Gonzales's gardens, *Phil. Nat. Herb. 102 Quisumbing*, March 9, 1934. This is the second time that this variety has come to the attention of the junior author. The first instance was a plant belonging to Mrs. Stewart, collected by her near Baguio in March, 1926. The second plant, the subject of this description, was originally collected from the mountains of Rizal Province and was found mixed with typical *Dendrobium anosmum*.

This is one of the purest white dendrobes known, and is endemic to the Philippines.

DENDROBIUM ANOSMUM Lindl. var. HUTTONII (Reichb. f.) Ames and Quis. comb. nov. Plate 1, fig. 3.

Dendrobium superbum Reichb. f. var. *Huttonii* REICHB. F. in Gard. Chron. (1869) 1206; ROLFE in Lindenia 6 (1891) 52, sub. *t. 264;* Orch. Rev. 29 (1921) 116; WILLIAMS, Orch. Grow. Man. ed. 7 (1894) 364; AMES, Orch. 2 (1908) 187.

Perigonio candido, labelli disco ac ungue purpureis.

A very striking novelty. The flowers are clear white. The disc of the lip bears two beautiful purplish blotches, and its base is of the same colour. For this beautiful thing we have to thank Messrs. Veitch, who obtained it through their late excellent collector, Mr. Hutton, from the Malayan Archipelago.

In habit and general features similar to the species. The stems are comparatively shorter and more slender. The flowers are beautiful, showy, slightly fragrant, and about 8.5 cm across. They resemble those of the former variety in being pure white throughout but have the throat of the labellum dark purple.

LUZON, Manila, Mrs. Remedios C. Gonzales's gardens, *Phil. Nat. Herb. 103 Quisumbing*, March 10, 1934. The plant was originally collected by orchid peddlers among the typical plants of *Dendrobium anosmum*, from the mountains of Rizal Province, Luzon.

This, like the former variety, is very rare and beautiful, having been seen by the junior author in Manila gardens but once during his many years of study of orchids. It is characterized by having white flowers with the throat of the labellum dark purple. This particular variety has also been reported from the Malay Archipelago.

DENDROBIUM CERINUM Reichb. f. **Plate 1, figs. 4 and 5; Plate 3, figs. 1 to 10; Plate 9, fig. 2.**

Dendrobium cerinum REICHB. F. in Gard. Chron. II 12 (1879) 554.

Dendrobium cerinum, n. sp.—Caule teretiusculo demum multum sulcato calamum aquilinum crasso; racemis brevibus paucifloris densifloris; sepalo impari ovato oblongove acutiusculo; sepalis lateralibus triangulo semiovatis obtuse acutis, in mentum teretiusculum apice abrupte acutum extensis; tepalis ovatis obtuse acutis; labelli ungue cum cornu retrorso in medio, lamina subrotunda laevi, antice minute denticulata, columna clavata—Flores cerini, nitidi, ochroleuci, brunneo lavatis. Lineae fuscae radiantes in basi laminae labelli.—Ex aff. Dendrobii sanguinolenti; labello tamen ac mentum multum recedens. Ex archipelago Sondaico viv. misit el. Burbidge ad dominos Veitch.

This is very near the well-known buff-coloured variety of Dendrobium sanguinolentum. The stem is half as thick as one's little finger, and much furrowed when old. It bears dense racemes of from four to six flowers, whose chin is thinner and abruptly acute, not thick and retuse as in the compared species. Ovaries and pedicels light rose. Sepals and petals light yellowish-ochre coloured, shaded with brown. The central rib of the mentum is light purple. The lip is just alarming. It mimics that of Dendrobium sanguinolentum, having a strong retrorse tooth on its claw. The blade, however, shows the best differences; it is oblong, not three-lobed, and its border, in lieu of being totally entire, shows numerous minute teeth on its anterior edge. The colour is light ochre with radiating brown lines at the transition of the blade into the claw. The whole flower is of very firm texture, and shining as if made from wax. The lip has sometimes a certain tendency to become three-lobed. I have to thank for materials Messrs. Veitch, who tell me that the plant was collected in the Malayan Archipelago by Mr. Burbidge. It flowered in July and September.

H. G. REICHENBACH F.

Stems terete, aggregated, subpendulous, fusiform, 4.5 to 17 cm long, 5.5 to 10 mm in diameter at the widest portion, angled and sulcate when dry, the nodes 1 to 2.5 cm distant. Leaves distichous, elliptic-lanceolate or oblong-lanceolate, 6 to 11 cm long, 1.8 to 3.2 cm wide, nervose, membranaceous, pale green, narrowed to the acute apex. Leaf sheaths green, membranaceous, deciduous on the lower part of the plant. Racemes short, pendulous, laxly few-flowered, up to 4.5 cm long, 2- to 3-flowered. Flowers 3.5 to 3.8 cm long, 3.5 to 3.8 cm across, odorless, with slightly inflexed spur. Bracts pellucid, minute, membranaceous,

1.5 to 2 mm long. Pedicellate ovary 2.3 to 2.5 cm long, slender. Lateral sepals very obliquely oblong-lanceolate, acute, 1.4 to 1.6 cm long, 7-nerved, forming with the column foot a mentum or spur which is elongate, slightly curved, obtuse, 1.9 to 2 cm long. Dorsal sepal lanceolate-ovate, subacute, 1.4 to 1.6 cm long, 7 to 8 mm wide, 7-nerved. Petals spreading, oblong-elliptic, rounded and minutely apiculate at the apex, 14.5 to 15.5 mm long, 7.5 to 8 mm wide, 5-nerved. Labellum simple, elongate, about 3 cm long, attached to the column-foot; claw linear-oblong, sharply sigmoid, with a retrorse tooth in the middle; lamina round-ovate, about 1.8 cm long, 1.7 cm wide at the broadest portion (when expanded), broadly rounded or slightly retuse at the apex, crenulate-denticulate on the margin; disc provided with a single broad rather obscure central fleshy band which is glabrous and extends from the column-foot nearly to the apex of the labellum. Column very short and stout, tridentate. Anther subquadrate-ovoid, about 3 mm long. 3.5 mm wide.

LUZON, Manila, Bureau of Science orchid house, *Phil. Nat. Herb. 104 Quisumbing*, February 28, 1933. The living plants were originally gathered by Novaliches orchid peddlers from the mountains of Rizal Province, Luzon, back of the town of Antipolo. The plants are now being cultivated in the Bureau of Science orchid house and in the gardens of Mrs. Remedios C. Gonzales. The description was based on Bureau of Science material which flowered in Manila February 28, 1933. The flowers are fairly large and odorless, and remain fresh for three to four days. Pedicellate ovary apple green; sepals straw yellow; petals and labellum chalcedony yellow; spur straw yellow with shades of ecru-olive and some very pale purple, light lumiere green at the tip.

In the herbarium of the senior author is a colored sketch of this species from the Reichenbachian collection in Vienna. Thanks to this authentic record, one more obscure species is now shown to be represented by a recent definite collection.

Apparently the original collection was destitute of leaves. It was described (and shown) as having light rose or reddish pedicellate ovaries whereas the recent collection has the pedicellate ovary apple green.

A species closely allied to *Dendrobium Guerreroi* Ames and Quis. but differing from it in its fusiform, short, angled stems, in its few-flowered racemes, in the color of the flowers, in the

shape of the spur, and in its denticulate-margined labellum with ovate-rounded lamina.

DENDROBIUM PHILLIPSII sp. nov. Plate 1, figs. 6 and 7; Plate 3, figs. 11 to 19; Plate 6, fig. 1.

Aff. D. Fairchildae. Caules penduli, aggregati, teretes, tenuiter-fusiformes, 45 ad 60 cm longi, 5 ad 7 mm in diametro. Folia lanceolata, acuta, papyracea, decidua, 11.5 ad 12.5 cm longa, 1.5 ad 2 cm lata. Racemi brevissimi, pauciflori; bracteae lanceolatae, acutae, 5 ad 6.5 mm longae. Sepala lateralia obliquissime triangulari-ovata, acuta, 1.6 ad 1.7 cm longa, columnae pedem secundum 1.2 ad 1.3 cm lata; mentum valde elongatum, obtusum, ad apicem haud inflexum 2.7 ad 3 cm longum. Sepalum dorsale ovato-lanceolatum, subacutum vel obtusum, 1.8 ad 1.9 cm longum, 9 ad 10 mm latum. Petala late oblonga vel oblongo-elliptica, apice rotundata, 1.7 ad 1.8 cm longa, circiter 8 mm lata. Labellum simplex, ovato-oblanceolatum cum parte inferiore oblonga sensim dilatata, antice ovato-triangulare, acutum, circiter 3.5 cm longum et 1.5 cm latum. Gynostemium brevissimum, crassum, apice tridentatum cum stelidiis lateralibus triangulari-ovatis leviter recurvatis et dente medio tenui, in pedem elongatum extensum.

Stems pendulous, crowded, terete, elongate, fusiform, 45 to 60 cm long, 5 to 7 mm in diameter, reddish-brown, smooth; internodes 2.5 to 4.5 cm long. Leaves lanceolate, acute, 11.5 to 12.5 cm long, 1.5 to 2 cm wide, papery, deciduous. Racemes short, few-flowered, 3 to 4 cm long; bracts lanceolate, acute, greenish, 5 to 6.5 mm long, 3 to 3.5 mm wide when expanded. Flowers about 1.8 cm across. Pedicellate ovary about 3 cm long. Lateral sepals very obliquely triangular-ovate, acute, 1.6 to 1.7 cm long, 1.2 to 1.3 cm wide along the column-foot; the mentum or spur stout, elongate, obtuse, straight, 2.7 to 3 cm long, 1.2 to 1.3 cm wide near its base. Dorsal sepal broadly ovate-lanceolate, subacute or obtuse, 1.8 to 1.9 cm long, 9 to 10 mm wide. Petals broadly oblong or oblong-elliptic, rounded at the apex, 1.7 to 1.8 cm long, about 8 mm wide. Labellum simple, ovate-oblanceolate with the lower part gradually narrowed and adorned with a low transverse lacerate ridge, about 3.5 cm long, triangular-ovate near the apex, acute, about 1.5 cm wide. Gynostemium very short, broad, with the lateral stelidia triangular-ovate and slightly recurved, and middle tooth slender. Foot elongate.

LUZON, Manila, Bureau of Science orchid house, *Bur. Sci. 85618 Quisumbing*, February 14, 1933. The above description was based upon a living flowering specimen sent to the junior author by Mr. L. H. Phillips, who collected it from the hills of Bukidnon, Mindanao. The flowers are white except the spur and the throat of the labellum which are apricot yellow.

This species is allied to *Dendrobium Fairchildae* Ames and Quis., but differs from it in having smaller and more-slender stems, straight spur, and broadly ovate-oblanceolate labellum.

This species is dedicated to Mr. L. H. Phillips, formerly of the Philippine Packing Corporation at Bukidnon, Mindanao. While he was there, he spent considerable time and effort in collecting orchids during week ends and holidays, and we owe to him our present knowledge of the orchid flora of Bukidnon.

DENDROBIUM SCHUETZEI Rolfe. Plate 1, fig. 2; Plate 3, figs. 20 to 27; Plate 6, fig. 2.

Dendrobium Schuetzei ROLFE in Orch. Rev. 19 (1911) 224, 20 (1912) 289, 308, 337, *fig. 47*, in Gard. Chron. III 50 (1911) 42, III 52 (1912) 229, fig. 102; G. WILSON in Orch. World 3 (1912) 19, *t.*; ROLFE in Bot. Mag. 139 (1913) *t. 8495;* AMES Orch. 5 (1915) 138, 7 (1922) 96, in Merr. Enum. Philip. Fl. Pl. 1 (1924) 354.

The original description reads as follows:

"DENDROBIUM SCHUETZEI ROLFE.—This is another striking Dendrobium, of the D. Dearei group, which has been introduced by Messrs. Sander & Sons, St. Albans, and of which a technical description has been prepared. It has very large white flowers, the petals are obovate-orbicular in shape, and the lip strongly three-lobed, with broadly-rounded side lobes, and the front lobe broadly obovate or nearly orbicular, with a distinct apiculus. The petals and lip are much broader than in D. Dearei, and altogether different in shape. It should prove a great acquisition." Rolfe, Orch. Rev. 19 (1911) 224.

Rolfe's Latin diagnosis, Bot. Mag. (1913) t. 8495, reads as follows:

Herba epiphytica, 15–40 cm. alta. *Caules* erecti, subcylindrici, medio incrassati, sulcati, basi attenuati, dense foliati. *Folia* subpatentia, elliptico-oblonga, obtusa, coriacea, 8–10 cm. longa, 2.5–3.5 cm lata. *Pedunculi* subterminales, breves, pauciflori. *Bracteae* oblongae, subacutae, breves. *Pedicelli* circiter 4 cm longi. *Flores* magni, speciosi, albi, labelli basi viridi. *Sepala* subpatentia; posticum oblongo-lanceolatum, acuminatum, 3 cm. longum; lateralia triangularia, acuta, carinata, 3–5 cm. longa; mentum obtusum, 1.3 cm. longum. *Petala* late ovato-orbicularia, apiculata, 4.5–5.5 cm. longa, 3.5–4 cm. lata. Labellum trilobum, 4–4.5 cm. longum; lobi laterales subincurvi, late rotundati; lobus intermedius subrecurvus, late obovatus, truncatus vel emarginatus, apiculatus, crenulatus, 3.5–4 cm. latus; discus basi obtuse carinatus. *Columna* lata, 6 mm. longa; alae falcato-oblongae.

Dwarf in habit; the stems erect, leafy, short, stouter at the middle, narrowed to the base, 15 to 30 cm long or more, 1.1 to 1.5 cm in diameter at the widest portion. Leaves oblong-lanceolate or elliptic-lanceolate, subacute or obtuse at the apex, narrowed to the base, subcoriaceous, 6 to 11 cm long, 1.6 to 3 cm wide. Raceme 3- to 5-flowered; bracts triangular, about 2 mm long. Flowers showy, odorless, 6 to 6.5 cm across, pure white except the throat of the lip which is emerald green with a few purple stains at the base. Pedicellate ovary greenish white, 5.5 to 6 cm long. Lateral sepals triangular, acutely acuminate, keeled, 3.5 to 4 cm long, 1.5 to 1.8 cm wide. Dorsal sepal lanceolate, sharply acuminate, 3.5 to 3.8 cm long, about 2 cm wide along the column-foot. Petals suborbicular-obovate, broadly obtuse or rounded, apiculate, 4 to 4.7 cm long, 3.8 to 4.2 cm wide. Labellum distinctly 3-lobed; lateral lobes semiobovate, broadly rounded, somewhat incurved, about 2.7 cm long and 1.1 cm wide near the apex; middle lobe somewhat recurved, broadly flabellate-obovate or nearly orbicular, truncate, or slightly retuse, apiculate, 2.4 to 2.6 cm long, 3.2 to 3.7 cm wide; the whole labellum pure white except the throat between the lateral lobes which has a patch of full green-yellow with short Victoria lake lines at the base. Spur white, pale olivine at the tip, short, obtuse, 1.3 to 1.4 cm long. Column broad and short, white, green dotted with Victoria lake at the base. Anther subquadrate in outline, white. Pollinia narrowly oblong.

LUZON, Manila, Bureau of Science orchid house, *Phil. Nat. Herb. 82 Quisumbing,* February 13, 1933, originally collected by Mr. L. Hachero from Surigao, Mindanao, presented to Doctor Quisumbing, and now growing in Bureau of Science orchid house. MINDANAO, Surigao, *W. Lyon s. n.*, February, 1917.

A species with the habit of *Dendrobium Dearei* Reichb. f. and *D. Sanderae* Rolfe and allied to them, but differing strikingly in the short, obtuse spur. In addition to the different spur, this species differs from *D. Dearei* in having much larger flowers with different petals; it differs from *D. Sanderae* in the color and details of the flowers.

Genus BULBOPHYLLUM Thouars

BULBOPHYLLUM LOBBII Lindl. Plate 2, fig. 1; Plate 4, figs. 1 to 8; Plate 7, fig. 1.

Bulbophyllum Lobbii LINDL. in Bot. Reg. 33 (1847) sub *t. 29* (as *B. Lobii*); W. J. HOOKER in Curtis's Bot. Mag. 76 (1850) *t. 4532.*

The original description reads as follows:

BOLBOPHYLLUM LOBII; folio petiolato obovato-oblongo coriaceo, pedunculo unifloro folio breviore, pedunculo nudo unifloro folio breviore, sic basi subglanduloso e bracteis squamaeformibus cucullatis falcatis subglandulosis erumpente, sepalis oblongis acutis lateralibus falcatis, petalis conformibus minoribus reflexis, labello longe unguiculato cordato ovato acuto canaliculato apice recurvo. Lindl.

Rhizome creeping, rather stout, 5 to 7 mm in diameter, with numerous simple or rarely branched roots which are 1 to 1.5 mm in diameter. Pseudobulbs pyriform-cylindric, asymmetrically curved, remote, rugose, monophyllous, sessile, 4 to 4.5 cm long, 1.7 to 1.9 cm in diameter at the widest portion near the base. Leaves oblong-elliptic, acute, coriaceous, rigid, about 12 cm long, 4.6 cm wide; the petioles about 3 cm long. Scape arising from the side of each pseudobulb, its base sheathed with imbricated, lanceolate, membranaceous bracts, which are 2.2 to 2.8 cm long; the peduncles provided with bracts, which are 1.5 to 2 cm long. Pedicellate ovary primuline yellow and minutely spotted with dark purplish brown, 4.5 to 5 cm long, the ovary conspicuously ridged. Flowers showy, the largest of all known Philippine bulbophyllums, solitary, 7.5 to 8.5 cm across. Lateral sepals strongly falcate, lanceolate, gradually narrowed to the acute apex, 7.8 to 8 cm long, about 2 to 2.3 cm wide at the widest portion near the base, 13-nerved, the anterior portion circinate. Dorsal sepal greatly elongated, narrowly lanceolate, gradually narrowed to the acute apex, about 9.5 cm long, 1.5 cm wide at the widest portion near the base, 11-nerved. Petals similar to the lateral sepals, 7.1 to 7.7 cm long, 1.1 to 1.2 cm wide at the widest portion near the base, 9-nerved. Labellum triangular-lanceolate, strongly recurved, fleshy, mobile, acuminate, cordate at the base, 2.8 to 3 cm long, 1.1 to 1.2 cm wide. Column very short, stout, free portion 9 to 10 mm high, laterally winged, produced into an elongated curved foot about 1.1 cm long, of which the terminal portion is free and bears at its apex the mobile labellum. Pollinia subglobose.

LUZON, Benguet Subprovince, Baguio, Mrs. G. H. Fairchild's gardens, *Bur. Sci. 85568 Quisumbing*, March 23, 1932. The living plants were originally collected by Mrs. G. H. Fairchild near Baguio.

Bulbophyllum Lobbii is the largest-flowered *Bulbophyllum* ever reported from the Philippines and is closely allied to *Bulbophyllum calossum* Ridl.

Genus PHALAENOPSIS Blume

PHALAENOPSIS MARIAE Burbidge var. ALBA Ames and Quis. var. nov. Plate 2, figs. 3 and 4; Plate 4, figs. 9 to 17; Plate 7, fig. 2.

Haec varietas floribus omnino albidis haud striatis a *P. Mariae* differt.

In habit and in leaves similar to the species. The leaves, shining on the upper surface, dark green, 22.5 to 24 cm long, 5.5 to 7.7 cm wide. Scapes slender, sparingly branched, few-flowered, 10 to 20 cm long. Flowers odorless, 5 to 8 mm distant, 3.5 to 4 cm across, without bars and entirely pure white except at their apices which are light green-yellow and the inner basal portion of the lateral lobes of the labellum which is empire yellow. Pedicellate ovary white, about 12 mm long. Lateral sepals spreading, obliquely elliptic-ovate, obtuse, apiculate, 1.9 to 2 cm long, 1 to 1.1 cm wide. Dorsal sepal narrower, erect, broadly lanceolate-elliptic, obtuse, 1.9 to 2 cm long, 8.5 to 9 mm wide. Petals lanceolate-elliptic, obtuse, 1.7 to 1.8 cm long, 8.5 to 9 mm wide. Labellum fleshy, 3-lobed; lateral lobes erect in natural position, obliquely subquadrate-oblong, incurved towards the column, white with empire yellow stain on the inner basal portion, 5 to 6 mm long; middle lobe pure white, spatulate-obovate, 11 to 12 mm long, 7 to 8 mm wide at the widest portion, prominently keeled in the middle longitudinally, the keel conspicuously clothed with hairs on the anterior part. Column pure white, about 7 mm long.

LUZON, Manila, Bureau of Science orchid house, *Bur. Sci. 85707 Quisumbing*, June 21, 1933. The description is based upon a living plant (now growing in the Bureau of Science orchid house), which was donated to the junior author by Mr. L. H. Phillips, who collected it from the hills of Bukidnon, Mindanao.

The variety is characterized by having pure white flowers with a complete absence of bars on the sepals and petals.

The plate in Bot. Mag. t. 6964 shows a very similar middle lobe of the lip, and the length of the pedicellate ovary is variable in specimens in the herbarium of the senior author.

Genus AËRIDES Loureiro

AËRIDES LAWRENCIAE Reichb. f. var. FORTICHII Ames and Quis. var. nov. Plate 2, fig. 2.

Habitu speciei similis, floribus albidis differt.

A variety resembling the species in habit and general features. Leaves 15 to 22.5 cm long, 2.8 to 3.3 cm wide. Inflorescence

curving, about 42 cm long including the peduncles. Flowers fragrant, 3.1 to 3.2 cm across. Sepals and petals white faintly washed at center with sea-foam yellow, and devoid of purple at the tips. Lateral lobes of labellum white, the tips overlapping below the middle lobe; middle lobe rose-pink, margin denticulate. Spur goose green. Column white. Pedicellate ovary pale dull green-yellow.

LUZON, Manila, Bureau of Science orchid house, *Phil. Nat. Herb. 106 Quisumbing,* January 13, 1933. According to Mr. L. H. Phillips, formerly of the Philippine Packing Corporation, Cagayan de Misamis, Mindanao, who furnished the junior author with a living plant in flower, the Hon. Manuel Fortich, representative from Bukidnon, collected two plants from his ranch in Bukidnon Province, Mindanao.

As far as we know, this is the first time a white variety of *Aërides Lawrenciae* has been reported. The variety closely resembles the species in habit and general features, but differs in its white flowers. To Representative Fortich, of Bukidnon Province, this interesting and newly discovered variety is dedicated.

AËRIDES LAWRENCIAE Reichb. f. var. PUNCTATA Ames and Quis. var. nov. Plate 2, figs. 5 and 6.

Habitu speciei similis, floribus purpureis punctatis differt.

In habit and general features this variety resembles the species. The flowers are large, fragrant, about 3 cm across. Petals and sepals white tipped with true purple. Lateral lobes of the labellum white, dotted conspicuously with true purple, the dots extending up to the spur; the front lobe of the labellum true purple. The tip of the spur is buckthorn brown.

LUZON, Manila, Bureau of Science orchid house, *Phil. Nat. Herb. 107 Quisumbing,* November 12, 1932. The plant was originally collected by Mr. L. H. Phillips in the mountains of Cagayan de Misamis, Mindanao.

This variety is characterized by the conspicuous purple dots on the sides of the lateral lobes of the labellum.

Genus RENANTHERA Loureiro

RENANTHERA ELONGATA Lindl. Plate 2, fig. 7; Plate 4, figs. 18 to 25; Plate 8.

Renanthera elongata LINDL. Gen. & Sp. Orch. Pl. (1833) 218; AMES Orch. 5 (1915) 224, Bot. Mus. Leafl. Harv. Univ. 2 (1934) 31.

Renanthera micrantha BLUME, Rumphia 4 (1848) 54, Mus. Bot. Lugd.-Bat. 1 (1849) 60; REICHB. F. in Walp. Ann. 3 (1852) 566; MIQ. Fl. Ind. Bat. 3 (1859) 698; NAVES, Novis. App. (1882) 240.

Renanthera matutina LINDL. in Bot. Reg. 29 (1843) *t. 41*, G. K. in Bot. Zeit. 1 (1843) 760.

"Caule ramoso, foliis lato-linearibus oblique emarginatis, paniculis elongatis nutantibus, sepalis exterioribus lateralibus internis latioribus spatulatis, labelli limbo ovato basi bicalloso.

"Aërides elongatum. Blume l. c. [Bijdr. 366.]

"Hab. in Java, in rupibus calcareis prope Kuripan, Blume. Flores punicei."

Epiphytic on trees. In habit similar to *Renanthera storiei*. Stems erect, 210 to 215 cm high. Leaves distichous, greenish, oblong-elliptic, unequally bilobed at apex, 6.5 to 11.3 cm long, 2.7 to 4 cm wide, 3 to 4.5 cm distant. Peduncles 11.5 to 11.8 cm long. Panicles many-flowered (50 to 70 or more). Flowers small, of the same color as *Renanthera stoirei* var. *philippinensis*, 13 to 14.5 mm long, 9 to 10.5 mm wide. Pedicellate ovary slender, 9 to 11 mm long. Lateral sepals asymmetrically spatulate, clavate, rather abruptly dilated above, 6.5 to 7 mm long, 3.5 to 4 mm wide above the middle, about 1 mm wide across the claw. Dorsal sepal oblong-oblanceolate, obtuse, 7 to 7.5 mm long, about 3 mm wide at widest portion. Petals very similar to the dorsal sepal but smaller, broadly rounded at the apex, 5.5 to 6 mm long, 2 mm wide. Labellum relatively small, fleshy, 3.5 to 3.75 mm long, deeply saccate-spurred at base; 3-lobed at the apex; lateral lobes transversely subquadrate, broadly truncate, about 1 mm high; the middle lobe strongly recurved, triangular-ovate, subacute, about 1.25 mm long, 1 to 1.10 mm wide; spur cylindric-conic, about 2 mm long. Column minute, 1.5 mm long. Anther broadly ovoid, about 1.5 mm long, 1.25 mm across. Pollinia four.

MINDANAO, Zamboanga Province, on a small island on the east coast of Zamboanga, *Mrs. Kenneth B. Day s. n.*, September, 1932. The plants were epiphytic on trees in mangrove swamps.

This species is characterized by its very small flowers.

Genus VANDA Jones

VANDA MERRILLII Ames and Quis. var. ROTORII Ames and Quis. var. nov. Plate 2, fig. 8; Plate 9, fig 1.

Haec varieta floribus omnino badiis neque striatis neque maculatis a *Vanda Merrillii* differt.

In habit and flower parts very similar to the species. The flowers are essentially the same in size; the sepals and petals

are ox-blood red within, and chalcedony yellow on the back; the lateral lobes of the labellum pure white; the middle lobe of the labellum Vandyke red except the base of the auricles which are chalcedony yellow; column naphthalene yellow, and the pedicellate ovary white.

LUZON, Manila, Doctor Rotor's gardens, *Phil. Nat. Herb. 109 Quisumbing*, February 9, 1934.

The plant was originally collected by a friend of Doctor Rotor from a tree along the road between Baler, Tayabas Province, and Cabanatuan, Nueva Ecija Province, Luzon.

This variety resembles var. *immaculata* Ames and Quis. in the complete absence of bars or maculations on the flowers, but differs in the ox-blood red petals and sepals and Vandyke red middle lobe of the labellum.

This variety is dedicated to Dr. A. B. Rotor, a lover of orchids.

Genus TRICHOGLOTTIS Reichenbach f.

TRICHOGLOTTIS GUIBERTII (Linden and Reichb. f.) Ames and Quis. comb. nov. Plate 2, figs. 9 and 10; Plate 4, figs. 26 to 35; Plate 10.

Cleisostoma Guiberti LINDEN and REICHB. F. apud Reichb. f. in Bot. Zeit. 20 (1862) 375, Xenia Orch. 2 (1867) 126, *t. 142.*

Vanda Guiberti LINDL. apud Linden and Reichb. f. in synon.

The present species, which is well figured in Xenia Orch. l. c., appears to be referable to the genus *Trichoglottis* as now interpreted, while the concept *Cleisostoma* Bl. is no longer generally upheld by orchidologists.

Moreover, *Trichoglottis Guibertii* is certainly allied to *T. luzonensis* Ames, both vegetatively and florally. On the other hand, the name *Staurochilus* was founded by Ridley on *Trichoglottis fasciata* Reichb. f. which had previously been referred by Bentham, apparently with logic, to Reichenbach's genus *Stauropsis.*

Such species as *Trichoglottis Guibertii, T. luzonensis, T. Dawsoniana, T. fasciata,* etc., certainly differ from the original conception of *Trichoglottis* in having large flowers with scarcely developed spur, and in having the inflorescences (more or less elongate) either loosely racemose or paniculate.

It seems highly probable that orchidologists will eventually be forced to agree with J. J. Smith, in referring to the genus *Trichoglottis* all these allied and intergrading species.

"Affine *Cleisostomati ionosmo* Lindl. labelli lamina pandurata, pilosula, carina postice bicruri a calcaris fundo in laminae fossam excurrente.

"*Vanda Guiberti* Lindl.

"Panicula multiflora. Flores illis *Vandae Roxburghii* aequales, colore fere *Anselliae*, extus pallide flaveolo-albi. Sepala cuneato-oblonga, obtusa. Tepala subaequalia. Omnia flavida annulis rufis. Labellum basi cum columnae basi connatum auriculis rectangulis hinc unidentatis bidentatisve; lamina pandurata, postice latior, apice emarginata, pilosula. Columna brevis, apice utrinque unifalcis, falcibus velutinis; lamella ovata apiculata cochleata sub fovea.

"Die Berichte über die am 24. September in Brüssel veranstaltete Ausstellung heben als wesentliche Merkwürdigkeit diese, vom Hrn. Director Linden ausgestellte und zunächst *Vanda Guiberti* genannte Orchidee vor.

"In der That ist dieselbe eine sehr merkwürdige acquisition, besonders wenn man erwägt, wie die Cleisostomen bis jetzt keine irgend hübschen Blüthen aufwiesen, es sei denn das doch gar bescheidene *Cl. ionosmum*. Unsere neue Art hat einen mächtigen Blüthenstand von Blüthen, die einen modernen deutschen Vereinsthaler decken, und deren braune Ringe auf Paille Untergrund einen guten Eindruck machen." Reichb. f.

Coarse, stout, epiphyte, approaching *Trichoglottis ionosma* in habit. Roots stout, elongate, glabrous. Stems elongate, 50 to 70 cm long, 10 to 14 mm in diameter, subterete. Leaves distichous, oblong-ligulate, 14 to 28.5 cm long, 2.5 to 3.3 cm wide, coriaceous, 3 to 3.5 cm distant, dark green, unequally bilobed at the apex with obtuse lobes. Peduncles rigid, erect when occurring on erect stems and rather pendent when on drooping stems, 4 to 6 mm in diameter. Inflorescences showy, laxly paniculate, many-flowered, inclusive of the peduncles, 16 to 35 cm long, glabrous. Ovary twisted. Flowers fleshy, 3.5 to 4.5 cm across. Lateral sepals elliptic-obovate, obtuse, 1.6 to 1.8 cm long, 9 to 11 cm wide, somewhat asymmetric. Dorsal sepal, obovate-oblong, rounded at the apex, 1.6 to 2.1 cm long, 7 to 9 mm wide. Petals spatulate, more or less falcate, rounded at the apex, 1.5 to 1.8 cm long, 7.5 to 9 mm wide above. Labellum trilobed, fleshy, shortly saccate-spurred at the base, 1.6 to 2 cm long, densely pubescent on both surfaces especially on the inner surface; lateral lobes erect and connate with the column, short, rounded-triangular, 1.5 to 2 mm high; middle lobe much larger than the lateral lobes, subquadrate-pandurate, recurved at the apex, retuse at the tip, 1 to 1.3 cm long, 8 to 9 mm wide at the broadest portion near the base, with a prominent longitudinal keel on the upper surface; spur shortly conical, obtuse, 4 to 5

mm long. Within the saccate base of the labellum (between the lateral lobes) there is a small, ovate, abruptly acuminate, deeply concave ligule, about 5 mm long. Column short, stout, 7 to 8 mm long, densely and minutely pubescent, on each side at the apex with upcurved falcate stelidia which are 3 to 3.5 mm long. Pollinia 4, united in pairs, unequal.

LUZON, Manila, Mrs. Remedios C. Gonzales's gardens, *Bur. Sci. 84716 Quisumbing*, June 22, 1932.

The living plants were originally collected on limestone rocks and on branches of trees in Quezon National Park, Tayabas Province, Luzon.

The flowers are fragrant, and remain open for about eight weeks. Sepals and petals marguerite yellow barred and spotted with Hay's russet or madder brown, pale lumiere green at the tips; lateral lobes of the labellum white outside, primuline yellow inside spotted with vinaceous rufous, middle lobe barium yellow spotted with vinaceous-rufous; ligule between the lateral lobes at the base white; keel of labellum and column white; spur marguerite yellow; arms of the column pompeian red; anthers amber yellow.

This species is now reported from the Philippines for the first time. It differs from *T. ionosma* and *T. luzonensis* in the form of the lip.

ILLUSTRATIONS

Plate 1

Fig. 1. *Dendrobium anosmum* Lindl. var. *Dearei* (Rolfe) Ames and Quis. comb. nov., front view of flower, × 1.

2. *Dendrobium Schuetzei* Rolfe, front view of flower, × 1 (circa).

3. *Dendrobium anosmum* Lindl. var. *Huttonii* (Reichb. f.) Ames and Quis. comb. nov., × 1.

4. *Dendrobium cerinum* Reichb. f., front view of flower, × 1.

5. *Dendrobium cerinum* Reichb. f., side view of flower, × 1.

6. *Dendrobium Phillipsii* Ames and Quis. sp. nov., front view of flower, × 1 (circa).

7. *Dendrobium Phillipsii* Ames and Quis. sp. nov., side view of flower, × 1 (circa).

Plate 2

Fig. 1. *Bulbophyllum Lobbii* Lindl., front view of flower, × 1 (circa).

2. *Aërides Lawrenciae* Reichb. f. var. *Fortichii* Ames and Quis. var. nov., front view of flower, × 1 (circa).

3. *Phalaenopsis Mariae* Burbidge var. *alba* Ames and Quis. var. nov., front view of flower, × 1.

4. *Phalaenopsis Mariae* Burbidge var. *alba* Ames and Quis. var. nov., side view of flower, × 1.

5. *Aërides Lawrenciae* Reichb. f. var. *punctata* Ames and Quis. var. nov., front view of flower, × 1 (circa).

6. *Aërides Lawrenciae* Reichb. f. var. *punctata* Ames and Quis. var. nov., side view of flower, × 1 (circa).

7. *Renanthera elongata* Lindl., front view of flower, × 4 (circa).

8. *Vanda Merrillii* Ames var. *Rotorii* Ames and Quis. var. nov., front view of flower, × 1.

9. *Trichoglottis Guibertii* (Linden and Reichb. f.) Ames and Quis. comb. nov., front view of flower, × 1.

10. *Trichoglottis Guibertii* (Linden and Reichb. f.) Ames and Quis. comb. nov., side view of flower, × 1.

Plate 3

Dendrobium cerinum Reichb. f.: *1*, dorsal sepal, × 1.5; *2*, petal, × 1.5; *3*, lateral sepal, side view of column, pedicellate ovary, and spur, × 1.5; *4*, labellum from above (expanded), × 1.5; *5*, side view of labellum (natural position), × 1.5; *6*, front view of column, × 1.5; *7*, anther from above, × 3; *8*, anther from below, × 3; *9–10*, pollinia, × 6.

Dendrobium Phillipsii Ames and Quis. sp. nov.: *11*, dorsal sepal, × 1 (circa); *12*, petal, × 1 (circa); *13*, lateral sepal, × 1 (circa); *14*, labellum from above (expanded), × 1 (circa); *15*, side view of ovary and column, × 2.5 (circa); *16*, front view of column, × 2.5 (circa); *17*, anther from above, × 4.5 (circa); *18*, anther from below, × 4.5 (circa); *19*, pollinia much enlarged.

Dendrobium Schuetzei Rolfe: *20*, dorsal sepal, × 0.5 (circa); *21*, lateral sepal, × 0.5 (circa); *22*, petal, × 0.5 (circa); *23*, side view of ovary, column, and labellum (natural position), × 1 (circa); *24*, labellum from above (expanded), × 0.5 (circa); *25*, front view of column, × 1 (circa); *26*, anther from above, × 2.5 (circa); *27*, anther from below, × 2.5 (circa).

PLATE 4

Bulbophyllum Lobbii Lindl.: *1*, dorsal sepal, × 0.5 (circa); *2*, petal, × 0.5 (circa); *3*, lateral sepal, × 0.5 (circa); *4*, front view of column and labellum (natural position), × 0.5 (circa); *5*, side view of ovary, column, and labellum (natural position), × 0.5 (circa); *6*, labellum from above (natural position), × 2 (circa); *7*, anther from above, very much enlarged; *8*, anther from below, very much enlarged.

Phalaenopsis Mariae Burbidge var. *alba* Ames and Quis. var. nov.: *9*, dorsal sepal, × 1 (circa); *10*, petal, × 1 (circa); *11*, lateral sepal, × 1 (circa); *12*, side view of column and labellum (natural position), × 2 (circa); *13*, labellum from above (expanded), × 2 (circa); *14*, front view of column and labellum (natural position), × 2 (circa); *15*, anther from above, × 6 (circa); *16*, anther from below, × 6 (circa); *17*, pollinia, × 6 (circa).

Renanthera elongata Lindl.: *18*, dorsal sepal, × 2.5 (circa); *19*, petal, × 2.5 (circa); *20*, lateral sepal, × 2.5 (circa); *21*, column and labellum from above, (natural position), × 3.5 (circa); *22*, side view of ovary, column, and labellum (natural position), × 3.5 (circa); *23*, anther from above, × 10 (circa); *24*, anther from below, × 10 (circa); *25*, pollinia, × 10 (circa).

Trichoglottis Guibertii (Linden and Reichb. f.) Ames and Quis. comb. nov.: *26*, dorsal sepal, × 3 (circa); *27*, lateral sepal, × 3 (circa); *28*, petal, × 3 (circa); *29*, side view of column and labellum (natural position), × 3 (circa); *30*, front view of column, × 3 (circa); *31*, column and labellum from above (natural position) × 3 (circa); *32*, labellum from above (expanded), × 3 (circa); *33*, anther from above, very much enlarged; *34*, anther from below, very much enlarged; *35*, pollinia, very much enlarged.

PLATE 5

Dendrobium anosmum Lindl. var. *Dearei* (Rolfe) Ames and Quis. comb. nov., habit, very much reduced.

PLATE 6

FIG. 1. *Dendrobium Phillipsii* Ames and Quis. sp. nov., flowers, approximately natural size.

2. *Dendrobium Schuetzei* Rolfe, habit, very much reduced.

PLATE 7

FIG. 1. *Bulbophyllum Lobbii* Lindl., habit, much reduced.
2. *Phalaenopsis Mariae* Burbidge var. *alba* Ames and Quis. var. nov., habit, very much reduced.

PLATE 8

Renanthera elongata Lindl., habit of the plant, very much reduced.

PLATE 9

FIG. 1. *Vanda Merrillii* Ames and Quis. var. *Rotorii* Ames and Quis. var. nov., habit, very much reduced.
2. *Dendrobium cerinum* Reichb. *f.*, habit, very much reduced.

PLATE 10

Trichoglottis Guibertii (Linden and Reichb. f.) Ames and Quis. comb. nov., habit, very much reduced.

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PLATE 1.

PLATE 2.

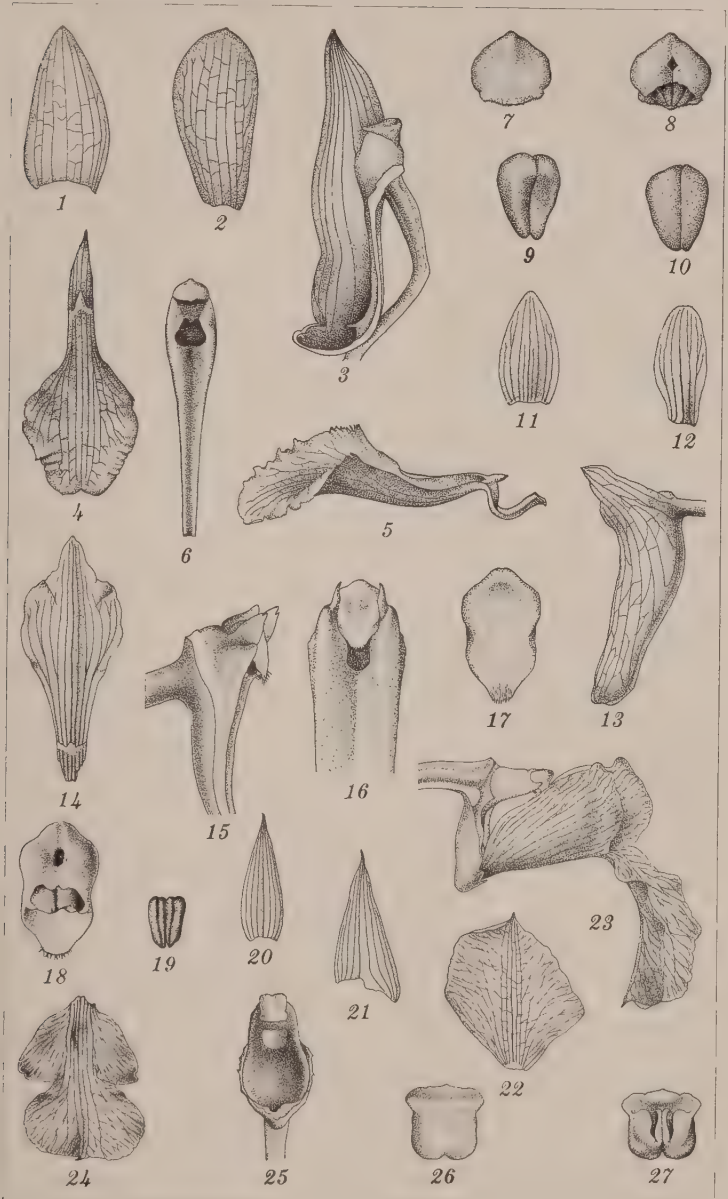

PLATE 3.

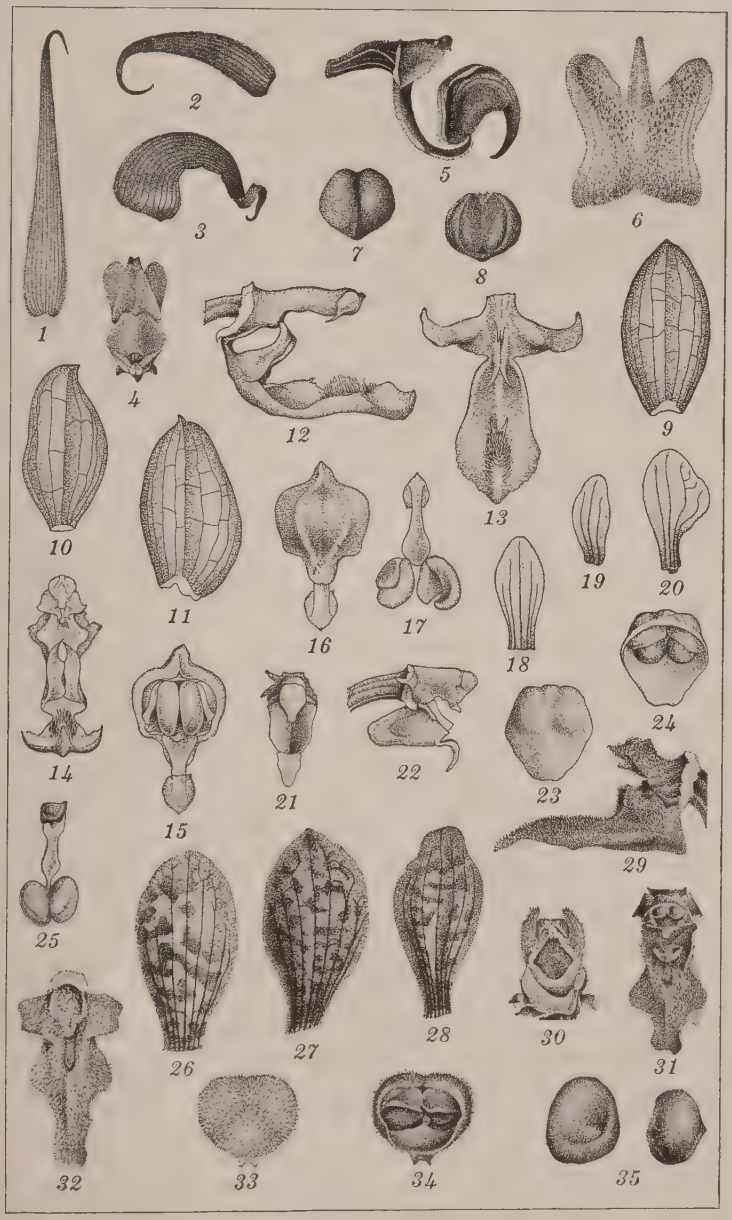
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PLATE 4.

PLATE 5.

PLATE 6.

PLATE 7.

PLATE 8.

PLATE 9.

PLATE 10.

ADDITIONAL FERNS OF KINABALU

By E. B. Copeland

Of the Department of Agriculture and Commerce, Manila

TEN PLATES

Christensen and Holttum have just published [1] a most valuable paper on the ferns of Mount Kinabalu, listing earlier collections, those by Mr. Holttum and collectors sent by him, and those of Mr. and Mrs. Clemens up to August, 1933. The Clemens expedition closed its work there in January, 1934. At Mrs. Clemens's request, Mr. Holttum being in England and identifications being urgently needed to make possible the distribution of the collections, I have undertaken to name the ferns collected during their last four months in the field. The number of additions made in this period is sufficient evidence that this mountain is by no means yet fully explored. These additions, with the Christensen and Holttum list, raise the number of Kinabalu ferns to 437 species.

The new and locally new species, and a few others inviting comment, follow.

CHRISTENSENIA AESCULIFOLIA (Blume) Maxon.

Above Kinitaki River, on wet hill, altitude 4,500 feet, *Clemens 50410*. Apparently new to Borneo. The same large form is in Java and Mindanao. A smaller one in Mindanao and the central Philippines is sometimes distinguished as *C. cumingiana*.

CYATHEA SUBBIPINNATA Copeland sp. nov. Plate 1.

Trunco, ut videtur, 3 ad 4 cm crasso, verosimiliter humile, apice stipiti conforme paleis immerso; stipite 25 ad 30 cm longo, paleis confertis castaneis pallide marginatis minute atrocastaneo-ciliatis deorsum 12 mm longis, 3 mm latis apiculatis utroque latere stipitis expansis insigniter ornato; fronde 60 cm longa, 20 cm lata subbipinnata, rhachi deorsum paleis decrescentibus ornata, sursum setulosa; pinnis infimis deflexis, brevi-stipitulatis, 10 cm longis, medio 23 mm latis, basi pinnata pinnulis saepius

[1] The ferns of Mount Kinabalu, Gardens' Bull. 7 (1934) 191–234, pls. 51–62.

1 libera et 2 adnatis, alibi pinnatifidis; pinnis medialibus sessilibus, 10 cm longis, 18 mm latis, acutis, costis glabrescentibus, segmentis falcato-rotundatis, 5 mm latis, nudis; venulis 6- vel 7-paribus, una basiscopica subapicale plerumque furcata caeteris simplicibus; soris inframedialibus, castaneis, nudis.

BORNEO, Mount Kinabalu, Gurulau spur, "crest of ridge, altitude 6,000 feet," *Clemens 50396*.

Similar to *C. bipinnatifida* Copel. of Basilan, which has very hairy axes and pale basal scales. The group is that of *C. squamulata*, which has narrower paleae and bullate squamules. This is perhaps the bipinnatifid plant referred to by Christensen and Holttum at the bottom of page 218, but I am unable to construe the plant in hand as a small *C. squamulata* or *C. elliptica*.

I mistrust, though, that we have a better developed specimen of this species in *Clemens 40354* from Dahobang River ridge, altitude 3,500 feet. It is a tree-fern 10 feet tall with tripinnatifid fronds on long stipes, the apical part, of course, bipinnatifid. The lobes are narrower than in *C. subbipinnata* as just described, more falcate, with three or four forked veinlets on the convex side, rather acute, the venation closer, and the veinlets salient on the upper surface. These differences might be correlated with greater exposure. The paleae are somewhat paler, and the double row of them extends up the rachis almost as far as there are pinnae. It has the aspect of *C. squamulata*, but is sharply enough distinguished from this by its nakedness.

CYATHEA HOLTTUMII Copeland sp. nov. Plate 2.

C. squamulatae affinis, trunco 1.5 m alto; stipite 45 cm longo, inferne paleis fuscis lanceolatis 5 mm longis rigide appressis vestito, lateribus paleis lanceolatis apice protractis nitidis fuscis patentibus integris densissime onusto; fronde 1.8 m (teste lectore) longa, ovata, apice excepta tripinnatifida, rhachi fusca, inferne setis ferrugineis plerisque 5 mm rarius usque ad 1 cm longis vestita, alibi densissime more stipitis paleacea; pinnis infimis 25 cm longis, 8 cm latis, rhachilla inferne setosa; medialibus 45 cm longis, 13 cm latis, rhachilla inferne glabrata, sessilibus, acutis; pinnulis subsessilibus basi truncatis, 6.5 cm longis 14 mm latis, acutis, $\frac{1}{2}$ ad costas pinnatifidis, papyraceis, inferne pallidis, costis inferne paleis albidis 0.5 ad 1 mm longis ovatis et lanceolatis adspersis, lobis 3 mm latis, approximatis, oblique subacutis, costulis squamulis paucis deciduis albis vestitis; ve-

nulis ca. 5-paribus quarum 1 vel 2 infra marginem convexum furcatis; soris fere medialibus, nudis.

BORNEO, Mount Kinabalu, "ridge south of Dahobang River, altitude 3,500 feet," *Clemens 40308*.

It is noted that this and the larger plant ascribed to *C. subbipinnata* are from the same locality. This one is distinguished by nonciliate paleae, the many long setae on the nether face of the rachis, and squamules on costae and costules. These distinguish it from *C. squamulata*. I do not know *Alsophila parvifolia* Holttum, which this may be; at any rate, that specific name is not valid for it in *Cyathea*.

DRYOPTERIS DENNSTAEDTIOIDES Copeland sp. nov. Plate 3.

Species aspectu Hypolepidis punctatae soris dorsalibus stipite paleaceo: rhizomate 1 cm crasso, adscendente, basibusque stipitum paleis rufis 2 ad 4 mm longis lanceolatis apice attenuatis sat dense vestitis; stipitibus approximatis non caespitosis, 45 ad 60 cm altis 2 ad 3 mm crassis, stramineis, paleis sparsis minutis aut lanceolatis aut in fibrilla angustatis vestitis; fronde anguste ovata, 60 ad 70 cm alta, tripinnata, membranacea, rhachibus minute fibrillosis, lamina nuda; pinnis remotis, subopppositis, subsessilibus, lanceolatis, usque ad 20 cm longis et 5 cm latis, acuminatis, majoribus rhachin versus paullo angustatis; pinnulis multis, sessilibus, 2 ad 2.5 cm longis, ca. 8 mm latis, obtusis; pinnulis [11] inferioribus adnatis, superioribus confluentibus, oblongis, 2 ad 3 mm latis, apice rotundato-truncatis, inciso-serratis dentibus utroque latere saepius 3; venulis simplicibus; soris medialibus, quoad venulas dorsalibus, orbicularibus, indusiis basi lata sursum curvata adnatis margine libera lobatis, in vetustate inconspicuis.

BORNEO, Mount Kinabalu, Penibukan, "base of wall north of Pinokok Falls," altitude 7,000 feet, *Clemens 50032*. "Feels clammy."

The paleae and the sori subterminal on the veinlets compel me to regard this fern as a *Dryopteris*, but it has the aspect of *Hypolepis*, or of *Dennstaedtia*, and an indusium strongly suggestive of that group of genera. By definition, it could best be *Cystopteris*, but I do not believe that to be its affinity.

DRYOPTERIS AURITA (Hooker) Christensen.

Penibukan, on rocks in river bed, altitude 4,000 feet, *Clemens 40306*. Described from northern India, and accredited to

Formosa. The Kinabalu plant agrees with the Himalayan better than does the Formosan.

DRYOPTERIS HALLIERI (Christ) Christensen.

Dahobang River, altitude 3,000 feet, *Clemens 40478*. Described from Dutch Borneo.

STENOLEPIA TRISTIS (Blume) v. A. v. Rosenburg.

Gurulau spur, altitude 12,500 feet, *Clemens 51392*. As remarked by Christensen and Holttum, the entire frond of the Kinabalu plant is like a pinna of the typical Javan one. If it were dwarfed by the environment, I would expect it to be more coriaceous; but it is less so. Unless the tripinnate form can be found on Kinabalu, it will be better to recognize them as specifically distinct.

POLYSTICHUM CLEMENSIAE Copeland sp. nov. Plate 4.

P. kinabaluensi C. Chr. affine, majus, paleis aterrimis, scilicet autem indusiis magnis distincto; stipitibus usque ad 35 cm altis, basi densissime alibi sparsius et decidue paleis ovatis usque ad 1 cm longis apice setaceo-attenuatis nitidis atris margine rufis fimbriatis, cum minoribus angustioribus rufis commixtis vestitis; fronde usque ad 40 longa et 15 cm lata, coriacea; indusiis 1 ad 1.2 mm latis, peltatis centro nigris, alibi rufis, margine fimbriatis, haud persistentibus; aliter P. kinabaluensi simile.

BORNEO, Mount Kinabalu, Gurulau spur, altitude 12,000 feet, "upper granite lobang," *Clemens 50864*.

It is possible that this is the perfectly developed form of *P. kinabaluense;* but the very numerous specimens in hand of that species show no tendency to produce the conspicuous black paleae of *P. Clemensiae,* nor are the smaller specimens of the latter without these.

POLYSTICHUM OPPOSITUM Copeland sp. nov. Plate 5.

Species gregis P. aculeati, stipite ultra 60 cm longo, fulvo, paleis membranaceis concoloribus usque ad 18 mm longis et 6 mm latis plerisque angustioribus sursum decrescentibus apice sublaceris vestito; fronde ultrametrale, vix tripinnata, rhachi praecipue superne paleis linearibus et setiformibus crinitis ciliatis vestita; pinnis remotis, oppositis, subsessilibus, linearibus, valde serrato-attenuatis, 25 cm longis, 2.5 ad 3 cm latis, rhachilla basi dense alibi sparsius squamulis et fibrillis crinitis vestita apicem versus nudis; pinnulis subsessilibus, oblique anguste triangulari-ovatis, majoribus 18 mm longis 8 mm latis, basi basiscopica excisa integra, acroscopica acuta, rarius ibidem usque ad

costam incisa cum pinnula [11] una libera, margine alibi serrulata dentibus acutis haud aristatis; soris parvis, utroque latere costae uniseriatis, medialibus, indusiis minutis, inconspicuis.

BORNEO, Mount Kinabalu, Masilau River, altitude 9,000 feet, *Clemens s. n.*, December 26, 1933. "Jungle, wet rocks; fronds 5 feet or more, no trunk."

Related to the common Philippine mossy-forest species variously identified as *P. horizontale* Presl, *P. moluccense* (Blume) Moore, and *P. aculeatum* var. *batjanense* Christ, distinguished from these by the narrow, remote pinnae, and paler paleae. *Clemens 29053* is listed, Gardens' Bull. 7 (1934) 258, as *P. parvifolium;* as represented by the specimens in hand and so named, it is no near relative of that species, but can better be regarded as a variant of *P. oppositum.*

TECTARIA NITENS Copeland sp. nov. Plate 6.

Rhizomate suberecto, lignoso, 6 mm crasso, basibusque stipitum paleis 4 ad 5 mm longis lanceolatis attenuatis integris castaneis dense vestitis; stipitibus confertis, ca. 20 cm altis, atris, nitidis, nudis; fronde deflexa, ovata, maxima visa 18 cm longa, 12 cm lata, profunde cordata lobis basalibus interdum imbricatis, ca. $\frac{1}{3}$ ad costam inciso-lobata lobis contiguis acutis falcatis quam longis latioribus, herbacea, glabra, minutissime ciliata; venatione laxa areolis costam secus maximis; soris multis sine ordine aspersis, superficialibus, indusiis persistentibus, integris, plerisque et reniformibus et in peltatas transeuntibus, nudis.

BORNEO, Mount Kinabalu, Penibukan, "jungle side hill under cliff," *Clemens 40652.*

Related to *T. melanocaulon,* but probably always simple, and with different indusia. The local *T. Holttumii,* of the same group, is hairy.

ATHYRIUM MEGISTOPHYLLUM Copeland sp. nov. Plate 7.

Diplazium, A. atrosquamoso affine, caudice ignoto; stipite ultrametrale, castaneo, basi densissime et parte inferiore sparsius paleis nitidis castaneis anguste linearibus usque ad 4 cm longis margini angustissime nigro-cinctis ibidemque spinis minutis nigris rectis inflexisve praeditis vestito, paleis demum dejectis, cicatricibus ornato; fronde enorme, vix tripinnata, rhachi glabra, rufa; pinna mediale 90 cm longa, 25 ad 30 cm lata, pedicello 2 ad 3 cm longo; pinnulis subremotis, pedicellatis (3 mm), 15 cm longis, 3 cm latis, acuminatis, basi truncatis, tenuiter papyraceis, glabris, fere ad costas pinnatifidis sinubus inferioribus rotun-

datis; segmentis 5 mm latis, obtusis, argute serrulatis; venis ca. 10-paribus, plerisque furcatis et fructiferis; soris costularibus, brevibus, indusiis vestigialibus, laceris.

BORNEO, Mount Kinabalu, Penibukan, "foot of Kinokok River falls at great wall," altitude 5,000 feet, *Clemens 40806*. "Frond 10 feet."

Judging by the specimens received here Christensen and Holttum have included three species in *A. atrosquamosum*. *Clemens 28391* and *28410* may represent this species, although the bases of the stipes bear only basal fragments of paleae, while the type, which is no juvenile specimen, bears a mass of apparently very durable crinite, fine, shiny-black ones. *No. 27122* is not this species, and our specimen of *27951* has no more than a generic resemblance to it.

DIPLAZIUM VESTITUM Presl var. BORNEENSE Christensen.

Diplazium vestitum Presl var. *borneense* CHRISTENSEN, Gardens' Bull. 7 (1934) 273.

I have not seen the varietal type collected by Holttum, but the Clemens specimens cited seem to me too distinct from the Philippine species to be regarded as a variety.

ATHYRIUM CUMINGII (Presl) Milde.

Penibukan, west ridge, in jungle, altitude 5,500 feet, *Clemens 50262*. Described from Luzon, where it is not rare; reported from Celebes.

ATHYRIUM MERRILLII Copeland.

Mixed with Clemens *50733* or *50577*.

In dealing with this group, I have already noted, Philip. Journ. Sci. 38 (1929) 138, how easily conspicuous group characters blind us to distinctive specific characters within the group. It is possible that *A. porphyrorachis*, *A. Merrillii*, and *A. altum* constitute one variable species, but I am still of the opinion that they are distinct and that at least two of them occur on Kinabalu; also, that there is in Borneo still another one, undescribed, with very acute segments.

"Retaining *A. fuliginosum* in *Asplenium*, it is unnatural to place this species (*A. porphyrorachis*) in *Diplazium*,"— Gardens' Bull. 7 (1934) 280. Quite so! But why retain it (*A. fuliginosum*) in *Asplenium?* It has the paleae, indusium, and bundles in the stipe of what Christensen still calls *Diplazium*, and is now more correctly named **Athyrium fuliginosum** *Asplenium f.*, Hooker, Spec. Fil. 3 (1860) 120. The most similar species

is *A. longissimum,* Philip. Journ. Sci. 38 (1929) 139, which is more slender and without the long pinnatifid apex. The resemblance to *Asplenium longissimum* is purely superficial.

It is obvious, as Christensen states, op. cit. 268, that there are very recognizable groups within *Athyrium,* as, following Milde, I construe the genus. It is by no means equally obvious that the group as a whole has more than one origin; and until this appears probable, or until the natural minor groups can be so defined as to constitute convenient genera, I can see no reason to modify my practice. Giving names in *Diplazium* to Oriental species already named in *Athyrium* appeals to me all the less because I believe that the genus *Diplazium,* as it might survive any natural breaking up of my genus *Athyrium,* will have no representative in this part of the world.

BLECHNUM EGREGIUM Copeland.

Penibukan, in hillside jungle, altitude 4,000 feet, *Clemens 40812.* Holttum seems to have seen and recognized this species, but it is not listed. Rather common in steep, damp places at middle altitudes, throughout the Philippines.

ITHYCAULON MOLUCCANUM (Blume) Copeland.

Penibukan, by Dahobang River, altitude 4,000 feet, *Clemens 40386.* Sumatra to Polynesia; apparently new to Borneo.

POLYPODIUM HECISTOPHYLLUM Copeland sp. nov. Plate 8, fig. 1.

Rhizomate minuto, paleis paucis ovatis hyalinis fulvis 0.6 ad 0.8 mm longis apice setiferis vestito; stipitibus paucis, caespitosis, ca. 3 mm longis; fronde 2 ad 3 cm longa, 3 mm lata, ad alam costae pinnatifida, herbacea, sparse pubescente pilis inconspicuis, costa nigra, prominente; segmentis oblique oblongis vel rhomboideis, decurrenti-connexis, apice rotundatis, majoribus saepe subbilobis, supramedialibus plerumque soriferis, monosoris, planis, vel siccitate apice reflexis; venis aut simplicibus aut rarius furcatis; sporangiis nudis.

BORNEO, Mount Kinabalu, Penibukan, "Jungle ridge, on dead limb, altitude 4,000 feet," *Clemens 40837;* also, *50880,* Gurulau spur, near camp. *No. 40962,* on dead branch, altitude 7,000 feet, is a mixture containing this and other minute ferns.

To the naked eye, this seems to be a *Calymmodon,* and it is probably a part of the material discussed by Christensen under *Polypodium consociatum,* Gardens' Bull. 7 (1934) 298. I exclude it from *Calymmodon* as much because of the nonentire segments and occasional forked veins, as because of the nonfolded fertile

segments. The resemblance seems to be a matter of parallel evolution, without real immediate affinity.

GRAMMITIS PETROPHILA Copeland sp. nov. Plate 9.

Rhizomate breve paleis brunneis lanceolatis 1.5 mm longis apice mox ob apiculam perditam truncato-rotundatis dense vestito; stipitibus congestis, 2 ad 3 cm longis, gracilibus nec debilibus, pube sordido dense velutinis; frondibus 10 ad 16 cm longis, 5 ad 7 mm latis, utrinque attenuatis apice saepe curvatis, subcoriaceis, costa inferne et margine pilis sparsis deciduis obsitis; venis bis furcatis ramo inferiore acroscopico sorifero, apicibus superne saepe glanduloso-conspicuis; soris ordinatis, medialibus, immersis, receptaculo elliptico; sporangiis nudis.

BORNEO, Mount Kinabalu, Penibukan, "on mossy rocks of Pinokok River below falls, altitude 5,500 feet," *Clemens 50133. No. 29061,* identified as *Polyp. fasciatum,* Gardens' Bull. 7 (1934) 293, is this species.

GRAMMITIS REINWARDTIOIDES Copeland sp. nov. Plate 10.

Rhizomate breve, paleis brunneis nitidis lanceolatis 1.5 mm longis apicibus protractis deciduis vestito; stipitibus gracillimis fasciculatis, ca. 1 cm longis, pilis pallidis usque ad 1.7 mm longis vestitis; fronde 10 ad 15 cm longa, 6 ad 9 mm lata, utrinque angustata, fusca, subcoriacea, costa et margine pilis longis ferrugineis obsitis, lamina fere glabra; venis late patentibus, furcatis, ramo acroscopico sorifero breve, altero haud ad marginem protracto; soris fere costalibus parvis, globosis (nec receptaculo elongato) superficialibus, sporangiis setiferis.

BORNEO, Mount Kinabalu, Penibukan, "epiphyte by Dahobang River, altitude 3,500 to 4,500 feet," *Clemens 40792.*

Differs from *G. Reinwardtii* in being more slender, less rigid, with longer hairs, and rather smaller sori. The veins are less conspicuous and less nearly horizontal, the acroscopic branch less extremely short. Whether or not this is the fern mentioned by Christensen, Gardens' Bull. 7 (1934) 295, as similar to *G. Reinwardtii,* I do not try to guess. It is more like the plant I distributed as *G. Jagoriana* than like that correctly so-called. The *Grammitis* species are all small and very similar in aspect; but they have still many distinguishing features, and these occur in all possible combinations. As far as is known, most of the species are quite local; and a single mountain with any rich fern flora, in this part of the world, always has a considerable number of them.

POLYPODIUM LASIOSORUM Hooker? Cf. Christensen and Holttum op. cit. 294.

Penibukan, altitude 4,000 feet, *Clemens s. n.*, January, 1933. This little fern is very distinct in appearance because of its copious long setae—up to 4 mm long, on fronds 3 mm wide and up to 6 cm long. I would deem it distinct from any Javan specimen I have seen, and from *"Grammitis pusilla γ lasiosora"* Blume and *Grammitis nana* Fée. But after writing a description of it, I find this not essentially different from Hooker's of *Polypodium lasiosorum*, made from specimens from Blume.

GRAMMITIS SETOSA Blume.

Masilao River, altitude 6,000 feet, *Clemens 51367*. The sori are rather more immersed and elongate than in Javan specimens.

GRAMMITIS CUNEIFOLIA Copeland sp. nov. Plate 8, fig. 2.

Rhizomate parvo, paleis brunneis lanceolatis apiculatis 1 ad 1.5 mm longis vestito; stipitibus fasciculatis, non articulatis, 1 ad 6 mm longis, gracilibus, pilis sparsis 0.3 mm longis ornatis; fronde lineari-oblanceolata, 5 cm longa, 2 ad 3 mm lata, obtusa, basi attenuata, subcoriacea, ubique setosa setis 0.6 mm longis aut solitariis aut subfasciculatis; venis inferioribus simplicibus superioribus furcatis ramis aequalibus; soris superficialibus globosis, setis multis protectis, confluentibus, sporangiis nudis.

BORNEO, Mount Kinabalu, Penibukan, "On dead branch, base of wall, north of Pinokok Falls," altitude 7,000 feet, *Clemens 40962, partim.*

Related to *G. Jagoriana*, but thinner, less stipitate with less conspicuously clustered hairs; sporangia naked. As Christensen correctly notes, Gardens' Bull. 7 (1934) 295, the plant I once distributed as *P. Jagorianum, Pterid. Philip. Exsic. 70*, is not at all that species.

OREOGRAMMITIS CLEMENSIAE Copeland.

As happened seventeen years before, Mrs. Clemens has collected this fern mixed with *Grammitis kinabaluensis, No. 51393*. It has been collected also by Holttum, with the comment by Christensen: "Certainly a distinct species, but the validity of the genus is very problematical,"—Gardens' Bull. 7 (1934) 292. Previously he wrote, Dansk Bot. Arkiv 6 (1929) 30, 31, "I should prefer to drop the genus and place the species in *Polypodium*," which for him includes *Grammitis*. The new material, very scanty still, shows some polypodioid sori, followed higher on the same fronds by unbroken coenosori.

The affinity to *Grammitis* is perfectly clear; that to *Scleroglossum*, suggested when the genus was published, does not exist, is only a misleading superficial resemblance. As far as affinity goes, it may well be reduced to *Grammitis*. So, with at least equal propriety, may *Nematopteris*, at least *N. interrupta—Polypodium pyxidiforme* v. A. v. R. *Polypodium pleurogrammoides* Ros. bridges the gap between *Grammitis* and *Scleroglossum*. The American genus *Cochlidium* has a distinct ancestry, but is equally without a distinct line of separation from polypodioid ancestors and relatives. Maxon has reduced *Xiphopteris* to *Polypodium* because there is no open gap between them and the affinity is clear. Those who reduce *Prosaptia* and *Acrosorus* to *Polypodium* have the same justification. And *Loxogramme* can be reduced to *Grammitis* almost as properly.

If affinity were the sole consideration, we would all agree on all of these reductions. It is the other criterion of the propriety of recognizing a genus which restrains me—that of convenience. Without the aberrant groups, *Polypodium* and *Grammitis* are big genera, but easy to define. Where the aberrant derived small groups are included, definition becomes too inconvenient for my taste.

SCLEROGLOSSUM INTERMEDIUM Copeland comb. nov.

Monogramma intermedia COPELAND, Philip. Journ. Sci. 1 Suppl. (1906) 255.

Gurulau, jungle spur, altitude 5,000 to 6,000 feet, *Clemens 50583, 50685*. Described from Negros. This may very well be *Taenitis simplicivenia* Cesati, but I do not see how it can be *Scleroglossum pusillum*.

ACROSORUS STREPTOPHYLLUS (Baker) Copeland comb. nov.

Polypodium streptophyllum BAKER, Journ. Bot. (1879) 42; C. CHRISTENSEN, Gardens' Bull. 7 (1934) 298.

Represented here by *Clemens 27992, 29506*, and supplementary collections. I am trusting Christensen's identification of the first of these, never having seen an authentic specimen of the species. But I cannot accept his reduction of *Acrosorus triangularis, A. exaltatus*, and *A. Frederici et Pauli* to this species. *Acrosorus exaltatus* may be a synonym of *A. triangularis*. If any other species is to be reduced to *A. streptophyllus*, it is *A. Merrillii*. This is known only by the type collection, which is more coriaceous, and with a better defined fertile portion of frond, than these Kinabalu plants. Further collection will show whether or not even these minor distinctions are constant.

I have called attention in the past to the tendency of very striking characters to make us overlook or undervalue those less conspicuous. If *Calymmodon cucullatus* and *Acrosorus streptophyllus* are retained in *Polypodium*, they appear so very peculiar there that features of size, texture, etc., are likely to be overlooked. It is only when the conspicuously peculiar features are construed as generic characters, that such features as would in general be accepted as characteristic of species command any attention.

POLYPODIUM (Better, GONIOPHLEBIUM) RAJAENSE C. Christensen.

This should not be construed as a variety of "Polypodium integriore."

ANTROPHYUM LATIFOLIUM Blume.

Penibukan, by waterfalls, altitude 5,000 to 6,000 feet, *Clemens 40294, 40963*. Known in Sarawak, but new to Kinabalu.

ILLUSTRATIONS

[All type specimens. Drawings by Borbe. Photographs by the Bureau of Science.]

PLATE 1

Cyathea subbipinnata Copeland sp. nov.: *1*, Frond, × 0.375; *2*, segment, × 3.7; *3*, palea of stipe, × 22.

PLATE 2

Cyathea Holttumii Copeland sp. nov.: *1*, Frond, × 0.35; *2*, segment, × 3.5; *3*, palea of stipe, base, × 20; *4*, palea of rachis, × 20.

PLATE 3

Dryopteris Dennstaedtioides Copeland sp. nov.: *1*, Plant, × 0.36; *2*, pinnule, × 22; *3*, sorus, × 21; *4*, palea, × 21.

PLATE 4

Polystichum Clemensiae Copeland sp. nov.: *1*, Plant, × 0.37; *2*, pinnule, × 3; *3*, sorus, × 21.5; *4*, palea, × 21.5.

PLATE 5

Polystichum oppositum Copeland sp. nov.: *1*, Frond, × 0.35; *2*, pinnule, × 2.1; *3*, palea, base, × 20.

PLATE 6

Tectaria nitens Copeland sp. nov. Type sheet, × 0.4.

PLATE 7

Athyrium megistophyllum Copeland sp. nov.: *1*, Part of stipe and frond, × 0.38; *2*, segment, × 23; *3*, sori, × 22; *4*, part of palea, × 22.

PLATE 8

FIG. 1. *Polypodium hecistophyllum* Copeland sp. nov.: *a*, Plants, × 0.57; *b*, one frond, × 2.3.

2. *Grammitis cuneifolia* Copeland sp. nov.: *a*, Plant, × 0.57; *b*, apex of frond, × 5.7; *c*, palea, × 34.

PLATE 9

Grammatis petrophila Copeland sp. nov.: *1*, Plants, × 0.41; *2*, detail of frond, × 4.1; *3*, detail of stipe, × 24; *4*, sporangium, × 31; *5*, palea, × 24.

PLATE 10

Grammatis Reinwardtioides Copeland sp. nov.: *1*, Plants, × 0.52; *2*, detail of frond, × 4.2; *3*, palea, × 30.

PLATE 1.

PLATE 2.

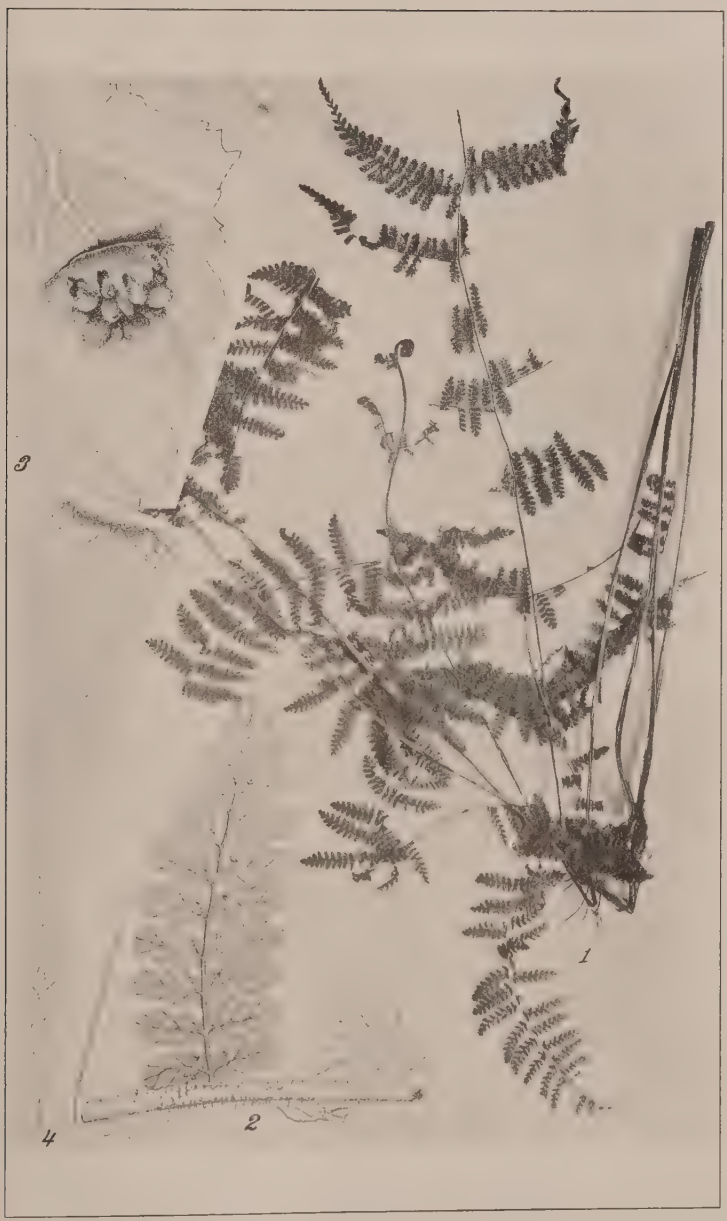

PLATE 3.

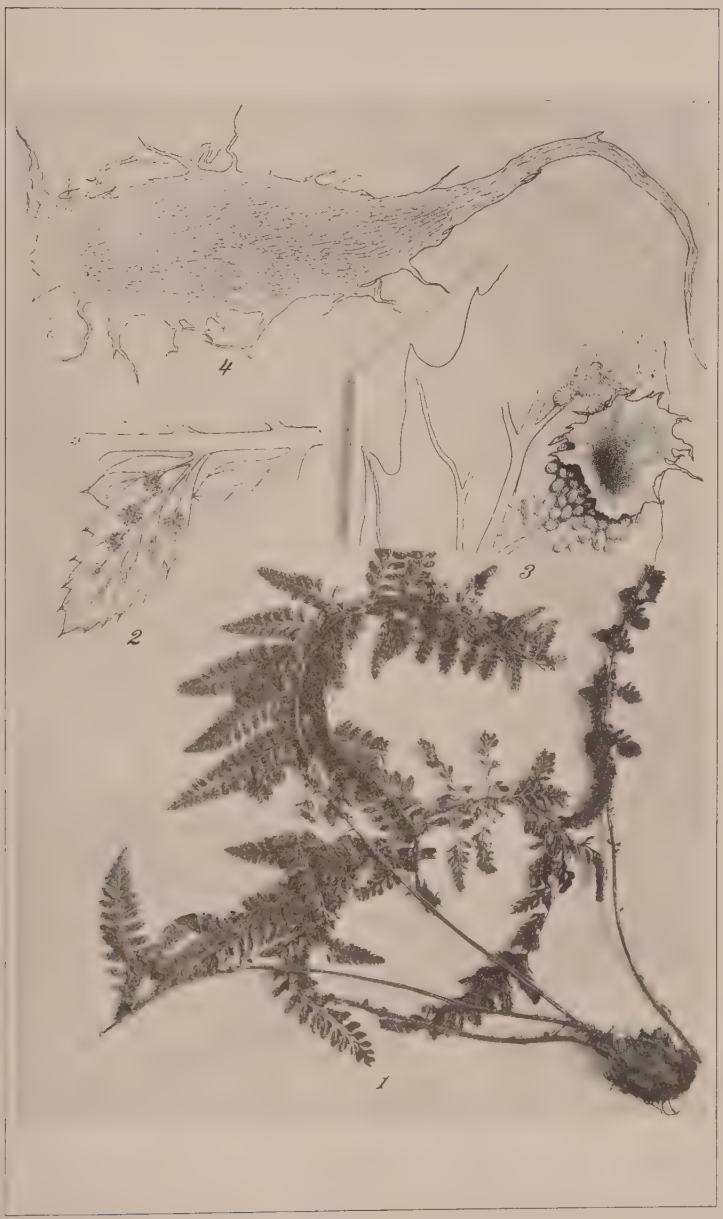

PLATE 4.

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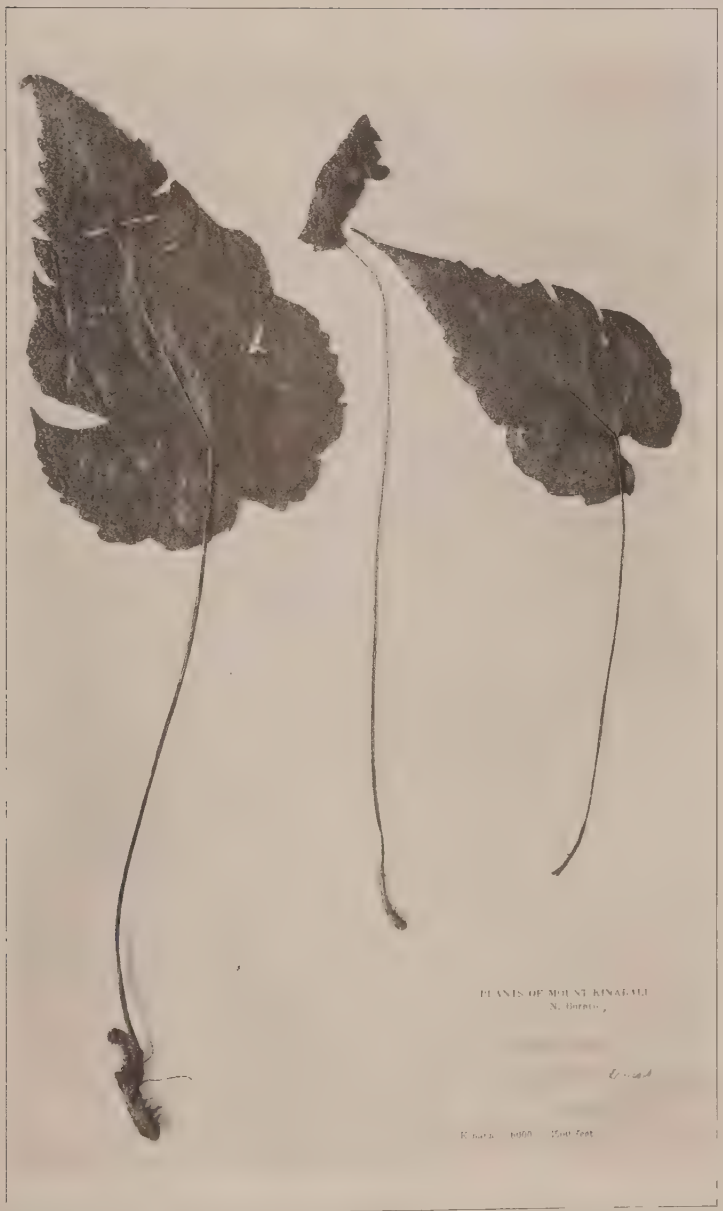

PLATE 6.

PLATE 7.

PLATE 8.

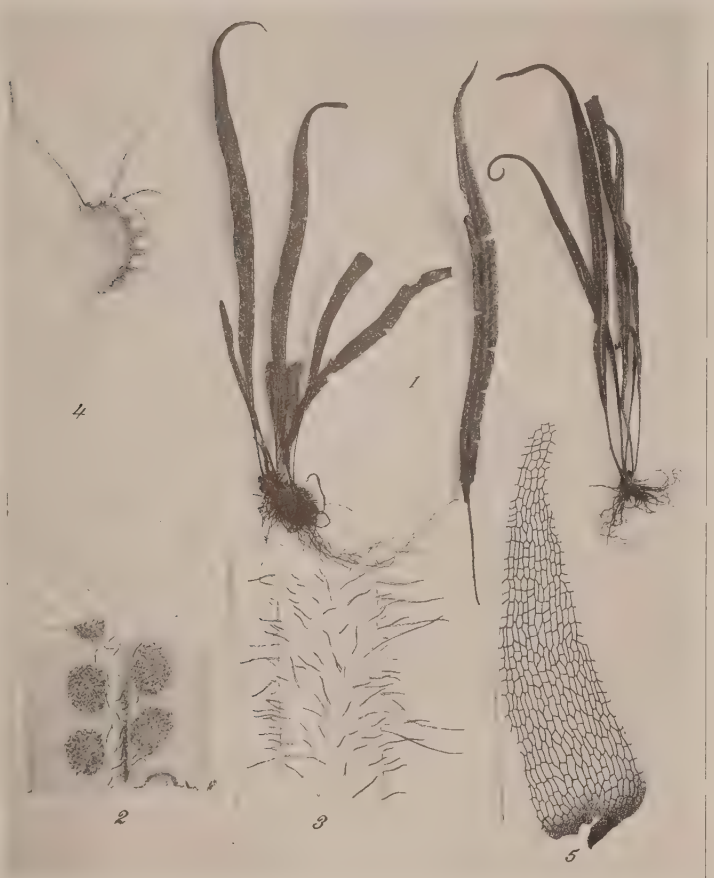

PLATE 9.

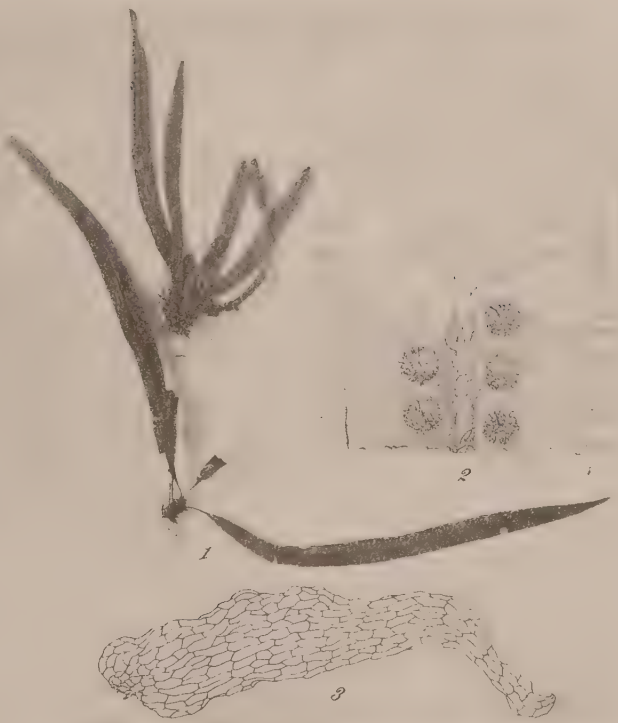

PLATE 10.

NOTES ON PHILIPPINE MOSQUITOES, I

THE ARMIGERES GROUP [1]

By F. E. Baisas

Of the Philippine Health Service, Manila

FOUR PLATES AND THREE TEXT FIGURES

The culicine mosquitoes of the Philippines have not been intensively studied. Undoubtedly a good collection from such important islands as Luzon, Mindanao, and Palawan will bring to light many interesting new forms. The main part of what is now known of Philippine culicines is the descriptions based upon specimens sent to Dr. C. S. Ludlow by the United States Army, to Dr. H. G. Dyar by Dean C. F. Baker, and by some other workers to the British Museum and elsewhere. It is regretable that no duplicate of this material was left in the Philippines, for direct comparison of new material should be made with such type specimens.

[1] Submitted for publication October, 1934. This study was made in the laboratory of Malaria Investigations of which Dr. Paul F. Russell is chief. Malaria Investigations is jointly supported by the Bureau of Science, Manila, and the International Health Board of the Rockefeller Foundation.

The material upon which the discussions are based was collected partly by me while I was stationed in the malaria field laboratory of the Bureau of Health at Tungcong Manga, San Jose, Bulacan Province, Luzon, and on anopheline collecting trips to Mindanao, Palawan, and other places, for Malaria Investigations; partly by the staff of the Bureau of Health malaria field laboratory who submitted to me for identification caught-wild mosquitoes; partly by Mr. D. Santiago and Mr. F. Guinto, of Malaria Investigations; and partly by the staff of the United States Army Medical Department Research Board, who sent mosquitoes to Malaria Investigations for determination. The mounting of adults and the dissection of male terminalia and other structures were done exclusively by Mrs. I. V. Ramos, of Malaria Investigations. All the drawings were traced by me with the aid of a camera lucida and inked by Mr. E. Enriquez and Mr. W. Garcia, artists of Malaria Investigations.

To all these people and particularly to the Director of Health, to Dr. C. Manalang, and to Dr. A. Ejercito, of the Bureau of Health, and to Dr. Paul F. Russell, under whom I have been assigned the last four years, I am greatly indebted.

Seven species are included in this paper, three of which are new. They are the following:

Armigeres (*Armigeres*) *ejercitoi* sp. nov.
Armigeres (*Armigeres*) *kuchingensis* Edwards, 1915.
Armigeres (*Armigeres*) *manalangi* sp. nov.
Armigeres (*Armigeres*) *russelli* sp. nov.
Armigeres (*Leicesteria*) *degitatus* Edwards, 1914.
Armigeres (*Leicesteria*) *flavus* Leicester, 1908.
Armigeres (*Leicesteria*) *magnus* Theobald, 1908.

The nomenclature employed in the following descriptions is in accordance with the latest published works of Edwards (1932), Christophers (1933), and Barraud (1934). Text figs.

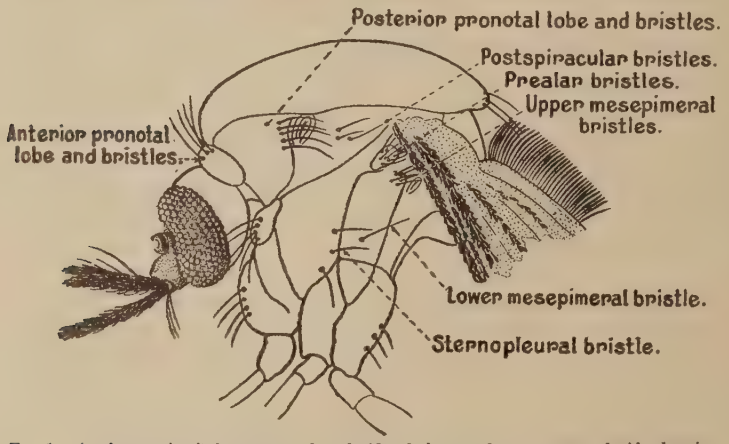

FIG. 1. *Armigeres ejercitoi* sp. nov., pleural side of thorax; from a camera-lucida drawing.

1 (pleural side of thorax) and 2 (male terminalia) show some of the more important parts.

ARMIGERES (ARMIGERES) EJERCITOI sp. nov.

Types.—Male (lot R28–4), and female (lot R28–3) with their corresponding larval skins; cotypes, 6 males and 7 females with their corresponding larval skins; and 10 males and 6 females without larval skins are all in the Philippine Bureau of Health collections at Manila. Collected by F. E. Baisas from Kolambugan, Lanao, Mindanao, March 21, 1934. Larva breeds in fairly good number in tree holes. Habits of adults unknown.

Adult (*male and female*).—Head clothed with dark brown flat scales, a few white ones on vertex; some upright forked

scales on nape. A border of creamy scales to eyes, somewhat broadening along sides. Clypeus dark, bare. Antennæ normal; tori with broad flat scales all around. Proboscis dark, shorter than front femur. Palpi dark, about one-fourth the length of proboscis in female, and longer by about the length of the apical segment in male. Thorax: Mesonotum covered with dark brown scales; a broad border of white scales along the margin from anterior side to above wing roots. Præscutellar area with a median patch of white scales forming a continuous white line with pale scales on middle of midscutellar lobe. Dark scales cover edges of middle lobe and the whole of two lateral lobes of scutellum. Anterior pronotal lobe covered with white scales. Pleura and coxæ with wide patches of broad, flat, silvery scales. Postspiracular bristles usually two, sometimes four. White scales but no black ones on postspiracular area. One lower mesepimeral bristle. Wings dark-scaled. Legs dark except undersides of fore and midfemora where there is a longitudinal line of white scales extending from bases to apices of segments. Hind femur extensively pale at about basal two-thirds or more underneath. Fore tarsal claws of female normal. Hind tibia as long as middle tibia. Abdominal tergites dark except VIII where there is a median basal pale patch or band. White lateral patches hardly visible dorsally on most of the segments; sternites extensively pale, particularly I and II. Apical dark patches or bands on III to VI; VII usually dark basally, white apically, entirely dark in some individuals.

Male terminalia (*Plate 1, figs. 1, 3 to 5, 7, and 8*).—Lobes of tergite IX not very prominent, bearing about nine spines each. The median thickening of sternite IX sometimes imperfectly fused with main chitinous part, and bearing about eight spines besides microtrichia. Coxite short and broad. Basal lobe and its spines represented by six or seven clublike spines, besides many smaller ones along inner border. Style rather short, bearing on its slightly expanded apex ten or eleven strong teeth.

The form of the style of the male terminalia resembles that of *Leicesteria*. Other characters, however, are distinctly of the subgenus *Armigeres* aside from the peculiar basal lobe. The shortness of the female palp, the presence of postspiracular bristles, and of white scales but no black ones on the postspiracular area, and the lower mesepimeral bristle, are characteristic of the subgenus *Armigeres*.

ARMIGERES (ARMIGERES) KUCHINGENSIS Edwards, 1915.

A widely distributed species; found in various places, both sylvan and urban, in Luzon and Mindanao; breeds in bamboo joints and tree holes.

Adult (*male and female*).—Head covered with broad flat scales, some scattered white ones on vertex, and upright scales on nape; a border of white to eyes, broadening at sides; remaining parts blackish. Clypeus black, bare. Antennal tori with broad flat scales. Proboscis dark, about as long as front femur. Palpi dark, less than one-third the length of proboscis in female, longer by about one-half the length of the ultimate segment in male. Thorax: Mesonotum covered with narrow dark brown scales, a border of pale ones around the edges from anterior margin to wing roots. The area behind the anterior pronotal lobe is extensively white and joins the white border line. Præscutellar area with a patch of pale scales at middle, forming a continuous line with white scales on middle of scutellar midlobe. Lateral lobes as well as the sides of midlobe of scutellum covered with dark scales. Anterior and posterior pronotal lobes covered with white scales. Postspiracular bristles present; white scales, but no black ones, on postspiracular area; one lower mesepimeral bristle. Extensive patches of white scales on pleura and coxæ. Wings dark-scaled. Legs dark except undersides of femora, which are whitish. Abdominal tergites covered with dark brown scales; tergite VIII with a wide, median, pale basal patch or band. White lateral patches on most of the segments, visible dorsally on posterior segments. Sternites white up to VI; VII dark basally, white apically. In some there are black apical patches on sternites III to VII. The white patches on the lateral side of tergites are continuations of the sternal white parts.

Male terminalia (*Plate 3, figs. 1, 3, 5, and 7*).—Lobes of tergite IX not very prominent, each bearing about ten spines. Sternite IX with median thickening bearing about seven spines arranged roughly in a single row. Coxite long and broad with numerous long spines. Basal lobe of coxite with three or four curved spines pointing toward the center of the coxite. Style with a row of strong teeth aligned on more than the apical half of the inner side; tip reaches basal lobe when pressed against coxite.

A single specimen sent to us from Mount Kinabalu, at about 4,000 feet elevation, Borneo, is very much like *A. kuchingensis*

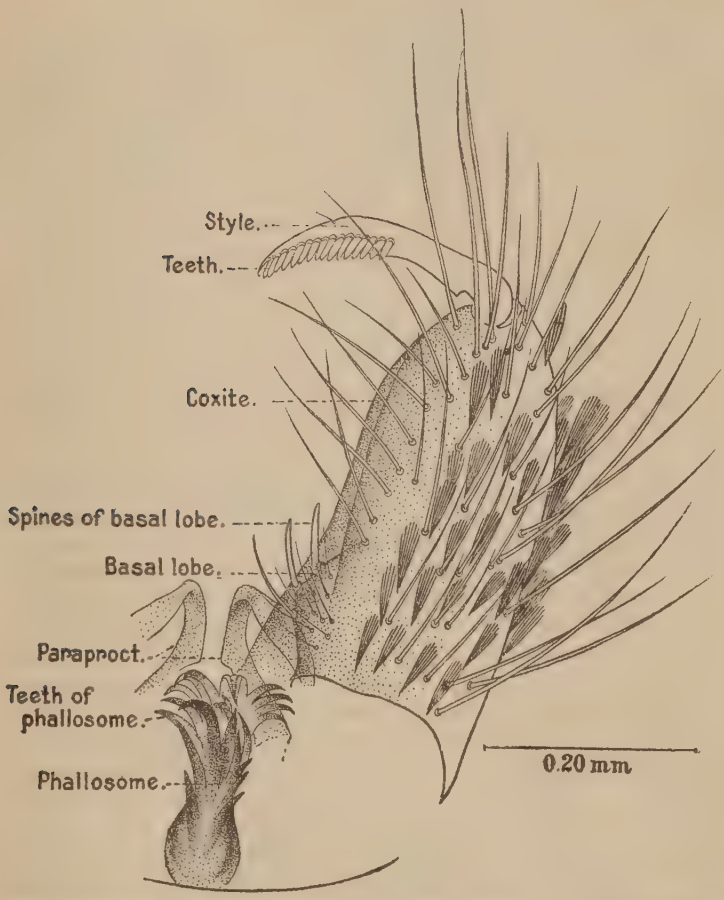

FIG. 2. *Armigeres* sp., from Borneo, one side of male terminalia; from a camera-lucida drawing.

in male genitalic characters (text fig. 2). The style, however, is shorter and the phallosome differs markedly from that of true *kuchingensis*. The specimen is not in good condition, and it is difficult to say exactly what it is.

Armigeres kuchingensis was previously known locally as *obturbans* Walker, 1860. In a personal communication Doctor Barraud called my attention to this matter.

ARMIGERES (ARMIGERES) RUSSELLI sp. nov.

Types.—Male (lot SR 1–x), and female (lot SR 1–y); cotypes 12 males and 5 females; all in the Philippine Bureau of Health collections, Manila. Collected by Mr. D. Santiago at Masiit, Calauan, Laguna, August 17, 1930. Known also from Mindanao (F. E. Baisas, 1932). Larva breeds in good numbers in tree holes, bamboo joints, and in axils of fallen areca-palm leaves.

Adult (*male and female*).—Head clothed with broad flat scales, some white ones on vertex; a few upright, forked, black and white scales at nape. A border of white scales to eyes, broadening at sides. Clypeus dark, clothed with broad, flat, creamy scales along edges; middle bare. Antennæ normal; tori with flat white scales along inner sides. Proboscis dark, about as long as front femur. Palpi dark, about one-sixth the length of proboscis in female, longer by about one-half the length of the ultimate segment in male. Thorax: Mesonotum covered with dark brown scales; a patch of white scales along the border behind the head and above the wing roots; these white patches sometimes imperfectly connected by scattered white scales between them. Præscutellar area with a median white patch connected with the line of broad, flat, white scales on midscutellar lobe. Black scales on sides of midlobe, and dark and pale ones on lateral lobes of scutellum. Anterior pronotal lobe clothed with pale scales. Extensive patches of broad, flat, silvery scales on pleura and coxæ. No spiracular bristle; postspiracular bristles present. A patch of white scales, but no black ones, covers the postspiracular area. One lower mesepimeral bristle in all specimens except one, which has two. Wings dark-scaled. Legs dark except undersides of femora, which are white. Fore tarsal claws of female normal. Hind tibia as long as middle tibia. Abdominal tergites clothed with dark brown scales; a basal median patch or band of pale scales on VIII. Lateral white patches not visible dorsally. Sternites mainly white.

Male terminalia (*Plate 2, figs. 2, 4, and 7, and text fig. 3, a.*)—Lobes of tergite IX prominent, each bearing about fifteen spines toward apex. Sternite IX with median thickening bearing about fifteen spines, besides two or three small flat scales. Basal lobe

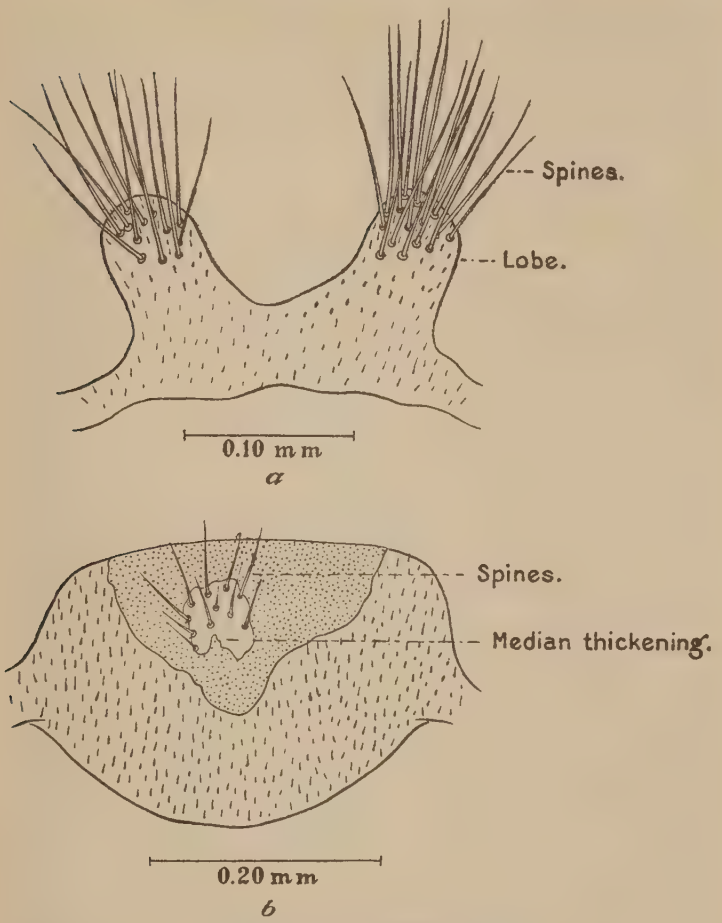

FIG. 3. *a*, *Armigeres russelli* sp. nov., ninth tergite; *b*, *Armigeres manalangi* sp. nov., ninth sternite; from camera-lucida drawings.

of coxite with six or seven spines, the one towards inner edge much longer than the rest. Coxite fairly long and broad. Style bears about fifteen strong teeth towards the apex, the uppermost longest.

This species closely resembles *Armigeres* (*Armigeres*) *malayi* Theobald (1901 and 1903), as given by Edwards (1917), and *Neosquamomyia breinli* Taylor (1914), but the male terminalia

differs in certain respects from the illustration given by Edwards (1917). The style of *russelli* is stouter, and its teeth are much longer. The spines of the basal lobe of the coxite are not arranged in one row, while the phallosome differs remarkably from that of any other *Armigeres* and does not seem to be like the one figured by Edwards.

ARMIGERES (ARMIGERES) MANALANGI sp. nov.

Types.—Male (lot PHS 1–x), and female (lot PHS 1–y) in the collection of the Philippine Health Service, Manila. Collected by Dr. C. Manalang at Tungcong Manga, San Jose, Bulacan, November, 1929. Larva breeds in small numbers in bamboo holes. Two males and three females bred out from larvæ collected from a bamboo joint by Mr. D. Santiago, at Mabacan, Calauan, Laguna, November, 1931. Habits of adults unknown.

Adult (*male and female*).—Head clothed with dark scales, some white ones on the middle of vertex; nape with upright forked scales. A border of creamy scales to eyes, broadening at sides; lateral white patches at about middle on either side. Clypeus black, nude. Antennæ dark; tori with broad, flat, creamy scales. Proboscis dark, slightly shorter than front femur. Palpi dark, a little over one-fifth the length of proboscis in female, and longer by about the length of the terminal segment in male. Thorax: Mesonotum covered with dark brown scales, a narrow border of white ones from anterior margin to wing roots. Præscutellar area with a patch of curved white, and broad white scales, forming a continuous line with white scales on middle of midscutellar lobe. Lateral lobes of scutellum with a mixture of dark and pale scales. Anterior pronotal lobe white-scaled. No spiracular bristle; postspiracular bristles present. A patch of white scales, but no black ones, covers postspiracular area; one or two lower mesepimeral bristles. Pleura and coxæ extensively covered with patches of silvery scales. Wings dark-scaled. Legs dark except the undersides of femora, which are white. Fore tarsal claws of female normal. Hind tibia as long as midtibia. Abdominal tergites with brownish black scales mixed with a few scattered pale scales. Lateral white patches on posterior segments visible dorsally. Sternites mainly pale.

Male terminalia (*Plate 2, figs. 1, 3, 5, and 6*).—Lobes of tergite IX fairly prominent, the spines of which are arranged along the inner borders. Sternite IX with a median thickening, bear-

ing seven to fifteen spines and numerous microtrichia. Basal lobe of coxite with three blunt-ended straight spines, little differing in length; also hairs of various sizes. Coxite fairly long and broad. Style very much expanded apically [similar to that of Edward's *Dunnius* (1930)], bearing over twenty strong teeth, besides numerous hairs of various lengths. Phallosome with about eleven teeth on either side.

ARMIGERES (LEICESTERIA) DEGITATUS Edwards, 1914.

Found by a number of workers in various places in Luzon. Larva breeds in small numbers in tree holes and bamboo joints.

Adult (*male and female*).—Head clothed with broad, flat, dark scales; a few white ones at middle of vertex; upright scales at nape. A border of pale scales to eyes; two lateral, broad, pale patches on either side. Clypeus dark, bare. Antennæ normal; tori with broad flat scales on the inner sides. Proboscis dark, about as long as front femur. Palpi dark, about two-thirds the length of proboscis in female, longer by about one-half the length of last segment in male. Thorax: Covered with dark brown scales, a border of broad pale scales around margin from anterior edge to wing roots; a pale patch at middle of præscutellar area contiguous with the line of broad, flat, pale scales at middle of midscutellar lobe. Rest of scutellum dark-scaled. Anterior pronotal lobe white-scaled. No postspiracular bristle; black scales anteriorly and white ones posteriorly occupy postspiracular area. No lower mesepimeral bristle. Pleura and coxæ with extensive patches of broad, flat, white scales. Wings dark-scaled. Legs dark except undersides of femora, which are white. Abdominal tergites dark brown; VIII with a pale basal patch or band. Lateral white patches visible dorsally on III to VII. Sternites extensively white with dark apices.

Male terminalia (*Plate 1, figs. 2 and 6*).—Tergite IX with prominent lobes, each bearing apically about twelve long spines. Coxite long, fairly broad. Basal lobe of coxite with about six sharp-pointed spines arranged roughly in double rows. Style with five strong spines at its apex.

ARMIGERES (LEICESTERIA) FLAVUS Leicester, 1908.

Males and females bred out from larvæ collected from tree hole at Lilio, Laguna, Luzon, by Mr. D. Santiago.

Adult (*male and female*).—Head clothed with broad, flat, pale scales; some upright scales at nape. Two dark patches on either side. Clypeus dark, bare. Antennæ normal, tori orange

with broad flat scales on inner sides. Proboscis dark, slightly shorter than front femur. Palpi dark, less than one-half the length of proboscis in female, longer by about the length of the ultimate segment and pale-ringed at the joints in male. Thorax: Mesonotum clothed with brownish scales, a border of pale scales from anterior margin to wing roots. Præscutellar area dark. Scutellar lobes pale-scaled. Anterior pronotal lobe dark above, pale below. Postspiracular area covered with black scales anteriorly and a white patch posteriorly. One lower mesepimeral bristle. Extensive patches of broad, flat, white scales on pleura and coxæ. Postnotum with one to four very minute hairs on posterior part, but no scales in specimens examined. Wings dark-scaled, except the humeral and the prehumeral areas of the costa, which are white. Legs dark brown; fore and mid-femora white beneath; hind femora white on the anterior and posterior surfaces; tibiæ pale basally; hind tibiæ with pale apical ring; mid and fore tibiæ with pale patches beneath. Tarsi with basal pale rings on first two or three segments, more conspicuous on the hind tarsi than on the others. Abdominal tergites dark; II to VI with pale, median, apical patches. Pale lateral patches visible dorsally only on VIII, which is otherwise entirely dark above, sometimes lateral pale patches also visible on VI and VII dorsally. Sternites pale.

Male terminalia (*Plate 4, figs. 1 and 4*).—Tergite IX with many strong spines at the apices of lobes. Coxite fairly long and broad; basal lobe with two or three blunt-ended spines. Style bears five teeth at its apex and a few scales on the outer border.

ARMIGERES (LEICESTERIA) MAGNUS Theobald, 1908.

A widespread species; found in several places in Luzon and Mindanao. Larva breeds in tree holes and bamboo joints. Female bites freely during the day in bamboo grooves.

Adult (*male and female*).—Head covered with broad flat scales; a patch of white towards nape; a pair of pale patches on either side laterally. A narrow rim of pale scales to eyes; remaining area dark. Clypeus dark, nude. Antennæ normal; tori dark with broad flat scales. Proboscis dark, about as long as front femur. Palpi dark, about two-thirds the length of proboscis in female, longer by about the length of last segment in male. Thorax: Mesonotum covered with dark brown scales; a

border of broad white scales around the margin from anterior side to wing roots. A patch of white scales at middle of præscutellar area. Midscutellar lobe with white scales posteriorly, dark ones anteriorly. Lateral lobes mainly dark-scaled, with a few pale scales posteriorly. Anterior pronotal lobe white-scaled. Postspiracular area occupied by a patch of dark scales anteriorly, and a patch of white scales posteriorly. No lower mesepimeral bristle. Pleura and coxæ extensively covered with patches of white scales. Wings dark-scaled. Legs with the femora pale underneath and at the apices; tibiæ pale at the apices; tarsi usually with pale basal patches on segments 1 to 3. Abdominal tergites dark brown with pale basal patches excepting I. Lateral white patches visible dorsally on III to VII. Sternites extensively pale with dark apices, and yellow basal patches, the yellow extending to the lateral and dorsal sides, forming complete basal bands on the posterior segments.

Male terminalia (*Plate 4, figs. 2, 3, 5, and 6*).—Lobes of tergite IX not prominent, each bearing about six to ten spines. Sternite IX without a median thickening. Coxite broad and fairly long. Basal lobe of coxite with three or four pointed spines. Style with about ten teeth at its somewhat expanded tip; there may be some scales on the outer border.

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ILLUSTRATIONS

Plate 1. Male Terminalia

Fig. 1. *Armigeres ejercitoi* sp. nov., coxite and style.
2. *Armigeres degitatus* Edwards, coxite and style.
3. *Armigeres ejercitoi* sp. nov., one side of phallosome.
4. *Armigeres ejercitoi* sp. nov., tip of phallosome, dorsal view.
5. *Armigeres ejercitoi* sp. nov., one lobe of ninth tergite.
6. *Armigeres degitatus* Edwards, one lobe of ninth tergite.

Figs. 7 and 8. *Armigeres ejercitoi* sp. nov., ninth sternites.

Plate 2. Male Terminalia

Fig. 1. *Armigeres manalangi* sp. nov., coxite and style.
2. *Armigeres russelli* sp. nov., coxite and style.
3. *Armigeres manalangi* sp. nov., phallosome.
4. *Armigeres russelli* sp. nov., one side of phallosome.
5. *Armigeres manalangi* sp. nov., one lobe of ninth tergite.
6. *Armigeres manalangi* sp. nov., ninth sternite.
7. *Armigeres russelli* sp. nov., ninth sternite.

Plate 3. Male Terminalia

Fig. 1. *Armigeres kuchingensis* Edwards, coxite and style.
2. *Armigeres obturbans* Walker, of India, coxite and style.
3. *Armigeres kuchingensis* Edwards, one side of phallosome.
4. *Armigeres obturbans* Walker, of India, one side of phallosome.
5. *Armigeres kuchingensis* Edwards, one lobe of ninth tergite.
6. *Armigeres obturbans* Walker, of India, one lobe of ninth tergite.
7. *Armigeres kuchingensis* Edwards, ninth sternite.
8. *Armigeres obturbans* Walker, of India, ninth sternite.

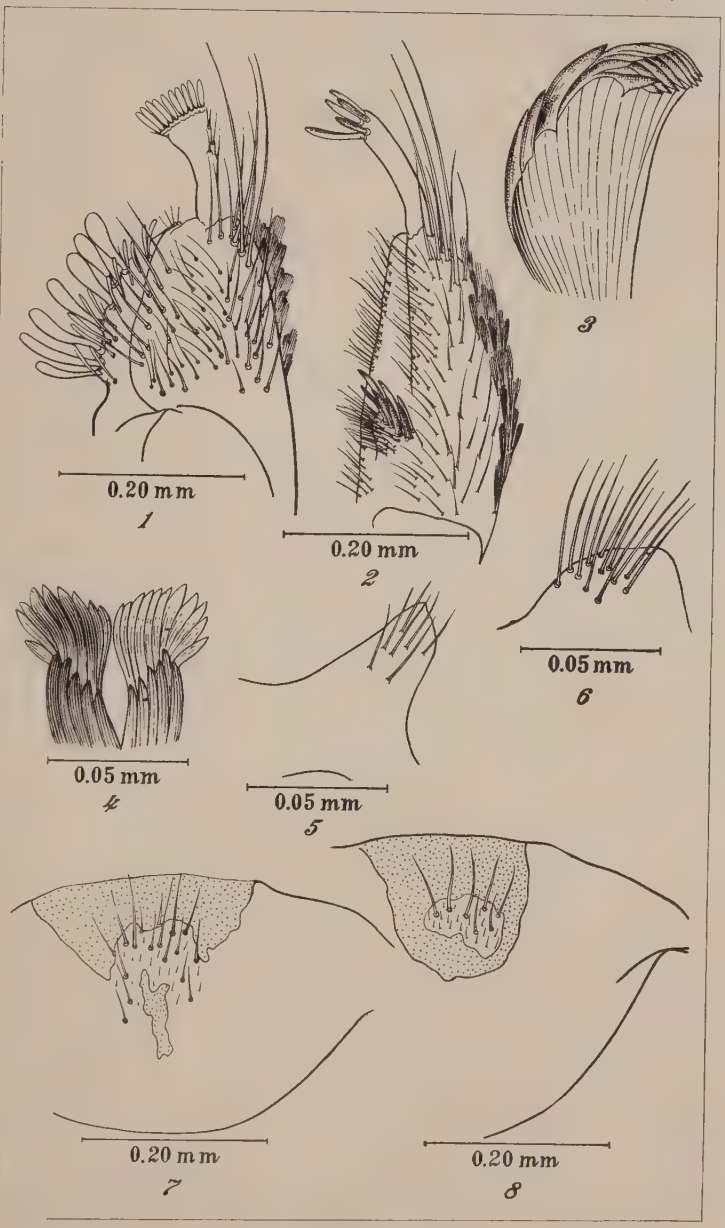
Plate 4. Male Terminalia

Fig. 1. *Armigeres flavus* Leicester, coxite and style.
2. *Armigeres magnus* Theobald, coxite and style.
3. *Armigeres magnus* Theobald, one side of phallosome.
4. *Armigeres flavus* Leicester, one lobe of ninth tergite.
5. *Armigeres magnus* Theobald, ninth tergite.
6. *Armigeres magnus* Theobald, ninth sternite.

Text figures

[From camera-lucida drawings.]

Fig. 1. *Armigeres ejercitoi* sp. nov., pleural side of thorax.
2. *Armigeres* sp., from Borneo, one side of male terminalia.
3. *a*, *Armigeres russelli* sp. nov., ninth tergite; *b*, *Armigeres manalangi* sp. nov., ninth sternite.



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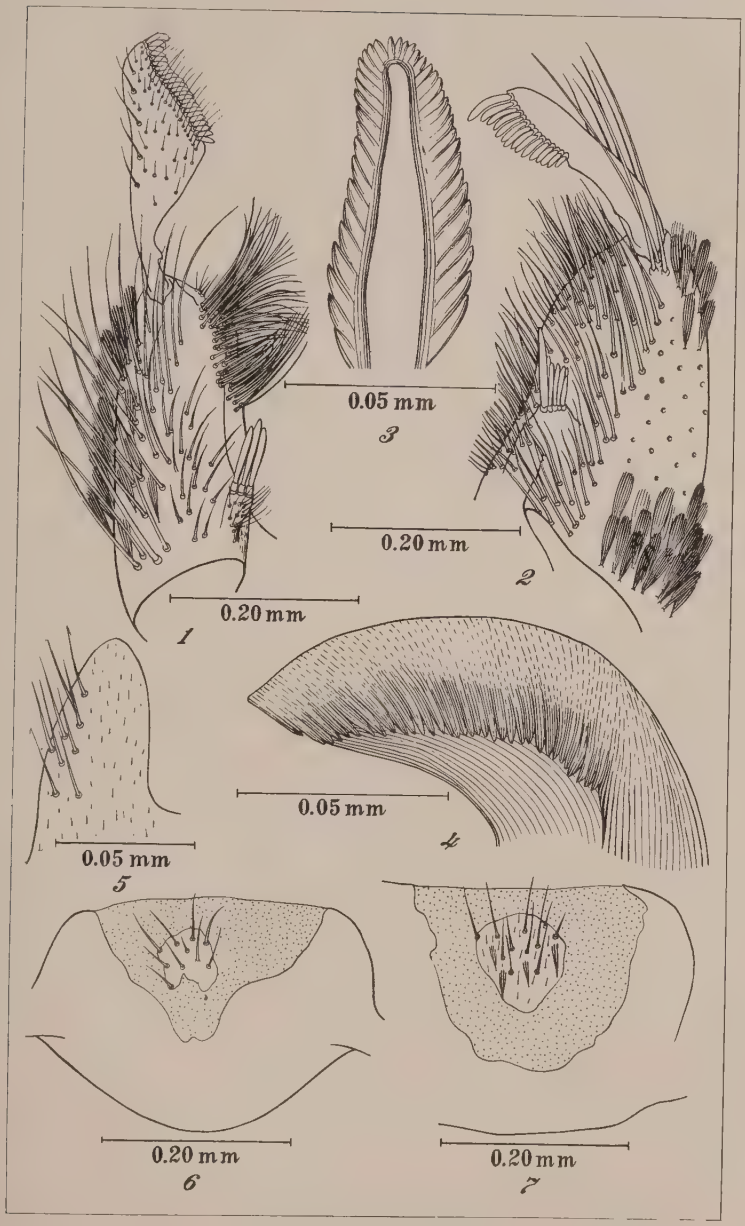

PLATE 2.

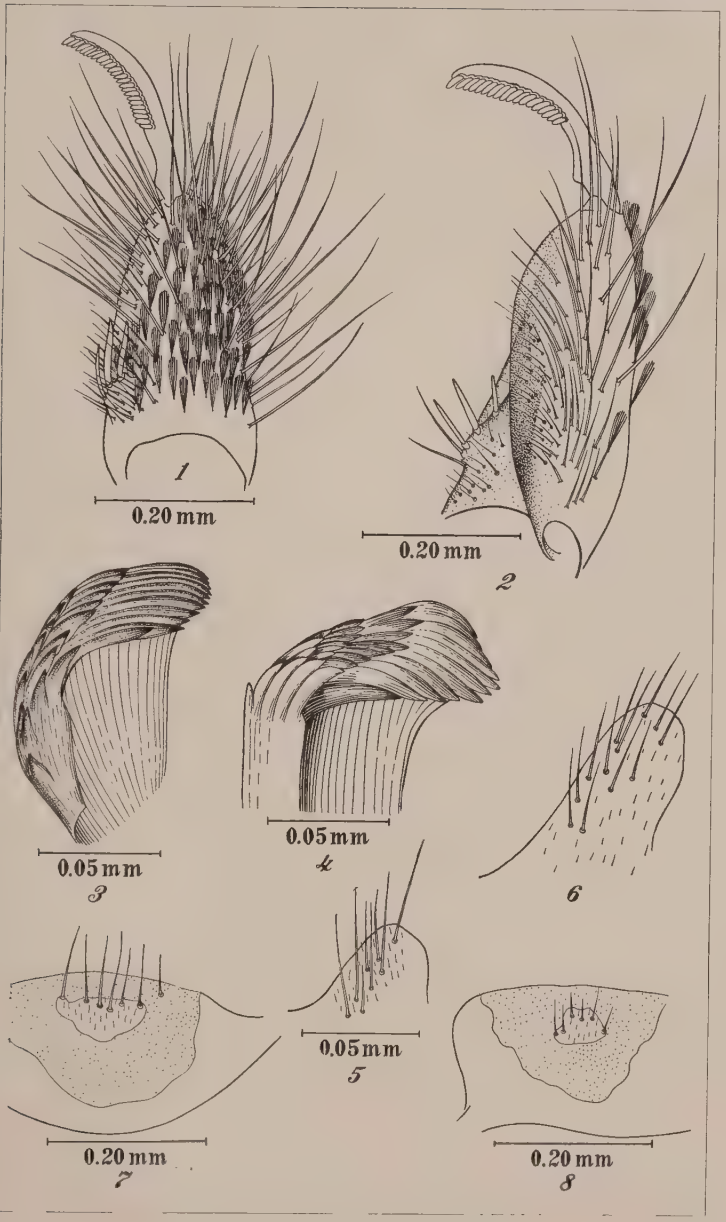

PLATE 3.

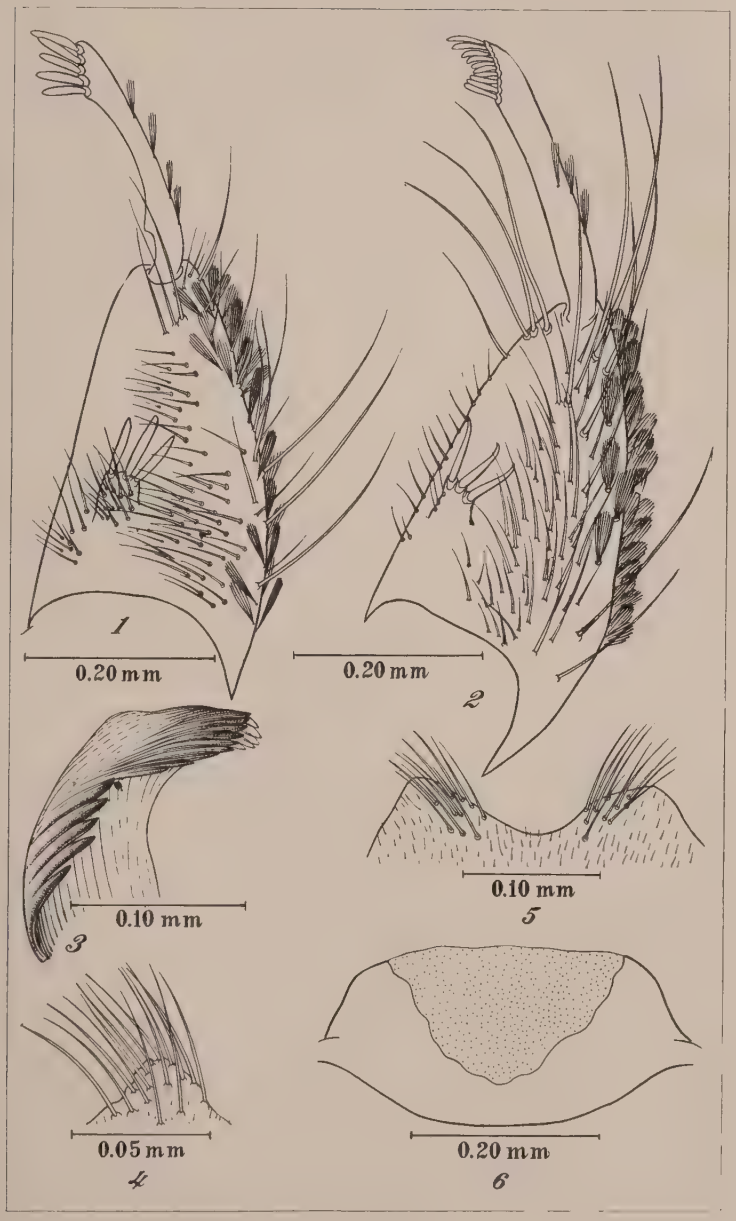

PLATE 4.

ADDITIONS TO THE APHID FAUNA OF FORMOSA (HEMIPTERA), III[1]

By Ryoichi Takahashi

Of the Department of Agriculture, Government Research Institute, Formosa

THREE TEXT FIGURES

EULACHNUS PINI sp. nov.

Wingless viviparous female.—Green, scarcely covered with secretions; body setæ dusky, each arising from a small dusky patch; cornicles, cauda, and anal plate dusky. In specimens treated with potash, antennæ pale brown; apex of fourth antennal joint, apical half of fifth, and sixth, except base, dusky; legs pale brown or brown, except tarsi and both ends of hind tibiæ, which are dusky. Body narrow, normal in shape, with many very long setæ, which are stout and tapering, but slightly capitate at the tip, and a little curved. Head divided by a median suture except on the posterior part, with some fourteen dorsal bristles including those on the front margin of dorsum, which are much longer than the first antennal joint. Eyes without distinct ocular tubercles. Antennæ slender, with long stiff or somewhat curved setæ, which are slightly capitate and shorter than those on the body; first joint as long as the longer setæ on the antennæ; second nearly as long as first, but much narrower, nearly twice as long as wide; third somewhat narrowed at the base, somewhat imbricated on distal half, lacking sensoria, with about seventeen setæ; fourth imbricated, with one or two small or rather large circular sensoria on distal half and about eight setæ; fifth with a very large oval or circular sensorium at tip; sixth with a similar sensorium at middle of distal part, which is somewhat smaller than that on fifth; relative lengths of joints about as follows: III—85 to 88, IV—42, V—45, VI—30 + 18. Rostrum reaching beyond middle coxæ. Cornicles small, not on cones. Cauda much wider than long, broadly rounded. Legs long, with many long slightly capitate setæ;

[1] Part II was published in the Philippine Journal of Science 52 (1933) 291–303.

setæ on tibiæ nearly as long as those on body; hind tibiæ very long, somewhat curved, much stouter than antennæ, slightly imbricated on distal part; tarsi long, imbricated, basal joint with a pair of long slightly capitate setæ on upper side, distal joint twice as long as basal; hind tarsi a little shorter than third antennal joint.

Length of body, about 3 millimeters; antenna, about 1.23; dorsal seta on head, about 0.138; hind tibia, about 1.57; hind tarsus, about 0.314; diameter of cornicle at apex, about 0.032.

Host.—*Pinus taiwanensis* Hayata, attacking the leaf.

Habitat.—Kyanrawa (altitude about 2,020 meters), Suo-gun.

Some specimens were collected by me August 15, 1934. The nymphs possess black legs. Closely allied to *Eulachnus piniformosanus* Takahashi, but differing in the following characters: (*a*) Body green, with scarce secretions; (*b*) body larger; (*c*) setæ darker, stouter, slightly capitate. Differs from the description of *Eulachnus tuberculostemmata* Theobald in the shorter rostrum, the cauda and anal plate black, the larger body, and the fourth antennal joint with one or two sensoria on the distal part.

AGRIOAPHIS ULMI-PARVIFOLIÆ Matsumura.

Tinocallis ulmi parvifoliæ MATSUMURA, Trans. Sapporo Nat. Hist. Soc. 7 2 (1919) 101.

Winged viviparous female.—Pale yellowish white; hind femora with a black part near distal end; wings slightly clouded at the end of each oblique and its branch and also at base of stigma. Head with three pairs of dorsal tubercles, of which the anterior two pairs are very short and conical, but the posterior pair is longer than wide. Antennæ slender, third joint with eleven to seventeen sensoria in most specimens, some with sixteen, in a row on the basal half, which are transversely narrowed. Pronotum with two pairs of stout dorsal tubercles that are longer than wide and larger than posterior ones on head; mesonotum with a pair of dorsal tubercles on hind part, which are nearly as long as those on pronotum. Abdomen with two pairs of dorsal tubercles on basal part, some with three lateral tubercles and some with very short indistinct dorsal ones; basal dorsal tubercles smaller than mesonotal ones. Cornicles wider than long, expanded basally, a little constricted about middle. Cauda knobbed, normal. Anal plate deeply bilobed, the lobes a little wider than long, as wide as cauda.

Host.—Ulmus parvifolia Jacquenot.

Habitats.—Habon (altitude, about 1,646 meters), near Musha; Kyanrawa (altitude, about 2,020 meters), Suo-gun.

Some specimens were taken by me August 10 and 15, 1934. Previously known from Honshu, Japan; new to Formosa. The Formosan specimens differ somewhat from the brief description by Matsumura, but no doubt belong to this species.

OREGMA ADERUENSIS sp. nov.

Wingless viviparous female.—Dark brown, with a purplish tinge, slightly covered with powder. Body oval, broadest on second abdominal segment, slightly convex dorsally. Dorsum slightly chitinized, with numerous rather small wax pores densely scattered over whole surface, except on eighth abdominal segment, and some long fine setæ somewhat curved; wax pores not well developed, indistinct, irregular in outline, but mostly nearly circular or oval, variable in size, separated from each other, semitransparent.

Head fused with prothorax, a little narrowed between antennæ, nearly straight on front between horns. Horns large, stout, as long as first antennal joint or slightly longer, somewhat diverging, narrowed on apical part, but rounded at tip, much longer than wide, sometimes slightly constricted basally and slightly curved, nearly as long as setæ on head, as long as distance between them or a little shorter, with a few short or long fine setæ. Eyes small, scarcely or not protruding laterally, with three facets. Antennæ short, curved, four-jointed, with a few rather long simple setæ, pale brown in specimens treated with potash; third joint somewhat narrowed on basal part, with a very small usual sensorium; relative lengths of joints about as follows: I—10, II—8, III—17, IV—11 + 4. Rostrum stout, not reaching middle coxæ. Cephalothorax, excluding horns, about one and one-half times as wide as long. Meso- and metathoracic and first and eighth abdominal segments defined, but second and following three abdominal segments fused, though sixth and seventh somewhat defined. Lateral setæ on abdomen a little longer. Cornicles short, not on hairy cones, much larger in

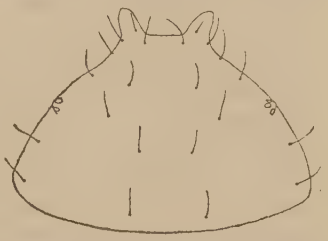

FIG. 1. *Oregma aderuensis* sp. nov.; cephalothorax of wingless viviparous female.

diameter at apex than dorsal pores. Cauda very short, but wide, somewhat constricted basally, broadly rounded on hind margin, with about six long setæ. Anal plate divided, each lobe slightly wider than cauda, with about six long setæ. Legs short, with some setæ; front tarsi with two very long setæ and two shorter ones on basal joint; hind tarsi a little longer than third antennal joint, with two very long setæ on basal joint; each distal tarsal joint with two very long fine setæ slightly capitate.

Length of body, about 1.65 millimeters; width of body, about 0.9; length of antenna, about 0.23; horn on front, about 0.051; hind tibia, about 0.37; diameter of apex of cornicle, about 0.032.

Host.—*Bambusa* sp., attacking the lower side of leaf.

Habitats.—Aderu (altitude about 1,170 meters), Heito-gun; Suisha.

Many specimens were taken by me November 23, 1929, and January 26, 1930, at Suisha, and a few specimens March 24, 1934, at Aderu. Described from specimens collected at Aderu. Closely allied to *Oregma tattakana* Takahashi, but differing in that the head is narrowed between the antennæ and the horns are narrowed on the apical part, as well as in the stouter tibiæ. Easily distinguished from *Oregma tattakana* Takahashi var. *suishana* Takahashi by the color.

MACROSIPHUM MONTICOLUM sp. nov.

Wingless viviparous female.—Green, slightly dusky near bases of cornicles; antennæ black, paler on basal part of third joint, not black on basal two joints, which are pale brown in specimens treated with potash; cornicles entirely black; cauda yellowish green; legs black on tarsi, distal parts of tibiæ, and distal halves of femora; body setæ pale. Body normal in shape, not imbricated, without granules and spinules on dorsum, but with many long stout setæ, which are somewhat curved, slightly or scarcely capitate, and each arising from a small tubercle. No thickened parts discernible on dorsum in specimens treated with potash. Head with four or five setæ in a transverse row between eyes, and two pairs of similar setæ in front of row. Frontal tubercles well developed, slightly convex, and with two setæ on mesal side, diverging, nearly as long as second antennal joint; setæ slightly or scarcely capitate. Antennæ very long and slender, with some rather long setæ, which are slightly capitate or simple and shorter than those on head; first joint slightly convex on mesal side, about twice as long as second; third somewhat striate on

basal part, with eighteen to twenty-two small, circular, slightly protruding sensoria, scattered except on basal and distal parts, and about twenty-two setæ; fourth slightly imbricated, wanting sensoria, with about eleven to thirteen setæ; relative length of joints about as follows: III—50, IV—33, V—32, VI—10 + 60. Eyes normal. Rostrum reaching hind coxæ, with some eight pairs of rather long lateral setæ, and many transverse rows of minute granules on basal joint. Prothorax with a very small, rounded, lateral tubercle. Setæ on thorax and abdomen nearly as long as those on head. Cornicles long, cylindrical, slightly curved, a little dilated towards base, not dilated at base, not swollen, imbricated, distinctly reticulated on distal one-fifth, about twice as long as cauda, a little longer than third antennal

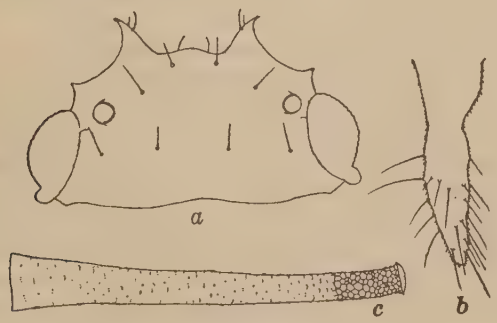

FIG. 2. *Macrosiphum monticolum* sp. nov.; winged viviparous female; *a*, head; *b*, cauda; *c*, cornicle of wingless female.

joint. Cauda long, constricted, rounded apically, with many setæ. Legs long and slender, with many rather long stiff setæ; hind tarsi nearly as long as basal part of last antennal joint, with five setæ on basal joint.

Length of body, about 2.6 millimeters; antenna, about 3; cornicle, about 0.9; cauda, about 0.47; hind tibia, about 2; seta on head, about 0.09; width of cornicle about middle, about 0.073.

Winged viviparous female.—Green, slightly dusky near bases of cornicles; head dusky; antennæ black, paler at base of third joint; cornicles black; cauda yellowish green; mesothorax pale brownish in specimens treated with potash, wings hyaline, stigma black, veins dusky; legs nearly as in wingless form. Third

antennal joint with about thirty-eight sensoria scattered except on the basal small part; fourth lacking sensoria; relative length of joints about as follows: III—54, IV—38, V—37, VI—10 + 75. Cornicles somewhat shorter than third antennal joint, expanded basally, slightly more than twice as long as cauda. Wing veins normal. Hind tarsi with five setæ on basal joint.

Length of body, about 2.6 millimeters; cornicle, about 0.78; cauda, about 0.32; hind tibia, about 1.9; forewing, about 3.5; seta on head, about 0.046; width of cornicle about middle, about 0.06.

In a winged form, hind tibiæ with numerous small circular or oval sensoria on basal half and cauda wider. This specimen is a viviparous female and is no doubt an abnormal form.

Host.—A plant of the Compositæ.

Habitats.—Miharashi (altitude about 883 meters), Taito; Riyohen (altitude about 1,121 meters), Rato-gun.

Some specimens were taken by me September 6, 1929, at Riyohen, and March 22, 1934, at Miharashi. This species seems to be closely related to *Macrosiphum parvum* Shinji, briefly described from *Aster* in Japan,[2] but differs from Shinji's description in possessing more sensoria on the third antennal joint, which is longer than the fourth, the fourth antennal joint as long as the fifth, and the femora paler on the basal part. Easily distinguished from *Uroleucon sonchi* Linnæus by the color. In the system of classification by Boerner this species must be included in *Dactynotus* Raf. (synonym, *Uroleucon* Mordwilko).

MACROSIPHUM TAIHEISANUM sp. nov.

Wingless viviparous female.—Entirely blackish brown. In specimens treated with potash, slightly pale brown, with many small dusky patches on sides and on posterior half of abdomen; abdomen likewise dusky on lateral part behind the cornicle; anal plate dusky; cornicles pale brownish, dusky on distal one-third; caudal pale brown; coxæ, femora, and tarsi black; tibiæ pale yellowish brown, black on basal and distal parts. Head somewhat chitinized, slightly corrugated on posterior part of dorsum, not imbricated, wanting granules, with a faint suture on anterior part of dorsum, a rounded frontal protuberance not visible from above, a pair of moderate, scarcely capitate, setæ on front, and also between antennæ, and two pairs of similar setæ between eyes. Frontal tubercles distinct, but short, not imbricated,

[2] Dubutsugaku Zasahi 34 (1922) 788.

slightly convex on mesal side. Eyes rather small. Antennæ long, slender, with some very small setæ; first joint as long as wide, somewhat angulated on mesal side, somewhat imbricated; third wanting sensoria; fourth somewhat imbricated; relative lengths of joints about as follows: III—37, IV—17, V—16, VI—10 + 20. Rostrum stout, reaching middle coxæ, with a pair of very long setæ near apex, which are directed laterally. Thorax and abdomen densely corrugated over dorsum and seeming to possess many, short, rounded papillæ, with a few short dorsal setæ, which are somewhat lanceolate. Cornicles long, rather stout, curved, directed posteriorly, nearly reaching middle or apex of cauda, not reticulated, distinctly imbricated on distal part and on mesal side, but not on basal part, gradually narrowed towards apex, a little longer than third antennal joint,

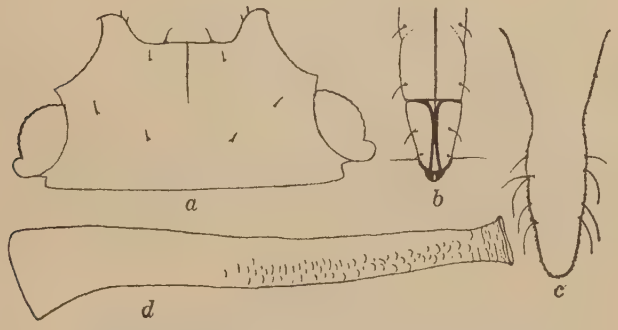

FIG. 3. *Macrosiphum taiheisanum* sp. nov.; wingless viviparous female; *a*, head; *b*, distal part of rostrum; *c*, cauda; *d*, cornicle.

twice as long as cauda. Cauda long, rounded apically, with a distinct constriction and about four or five long lateral setæ. Legs long, with many rather short setæ; tarsi imbricated, middle tarsi with three setæ on the basal joint. Anal plate rounded, with many long fine setæ.

Length of body, about 2.5 millimeters; antenna, about 2; cornicle, about 0.7; cauda, about 0.36; middle tibia, about 1; hind tibia, about 1.5; width of head at hind margin, about 0.44.

Host.—*Rhododendron formosanum* Hemsley, attacking the upper side of leaf on the midrib.

Habitat.—Taiheisan (altitude about 1,400 meters).

Four adult females were taken by me May 21, 1931. This species is peculiar in the corrugated dorsum and the curved

cornicles imbricated on the mesal side, and is not a typical form of the genus. Publication of the description of this species has been delayed in the hope that more specimens, including the winged forms, might be collected, but this hope has not materialized.

The type specimens are in the collection of the Department of Agriculture, Government Research Institute, Formosa.

ILLUSTRATIONS

TEXT FIGURES

FIG. 1. *Oregma aderuensis* sp. nov.; cephalothorax of wingless viviparous female.

2. *Macrosiphum monticolum* sp. nov.; winged viviparous female; *a*, head; *b*, cauda; *c*, cornicle of wingless female.

3. *Macrosiphum taiheisanum* sp. nov.; wingless viviparous female; *a*, head; *b*, distal part of rostrum; *c*, cauda; *d*, cornicle.

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EINIGE UNBESCHRIEBENE CURCULIONIDEN AUS DEM INDOMALAYISCHEN ARCHIPEL

58. BEITRAG ZUR KENNTNIS DER CURCULIONIDEN

Von EDUARD VOSS

Berlin-Charlottenburg, Deutschland

EINE TEXTFIGUR

Genus AULETORHINUS novum

Kopf quer, hinter den Augen undeutlich eingezogen. Augen stark halbrund vorgewölbt; die Stirn etwas breiter als die Augen lang. Rüssel schlank, fast gerade. Labrum vorhanden. Palpen starr. Fühler in der Nähe der Rüsselbasis eingelenkt. Keule lose gegliedert. Halsschild im basalen Drittel seitlich stark gerundet, konisch. Schildchen dreieckig. Flügeldecken länger als breit, unregelmässig punktiert; Schulterbeule schwach entwickelt. Pygidium gross, von den Flügeldecken unbedeckt. Tibien schlank, gerade. Klauen gespalten.

LARAT-INSELN.

Genotypus, *A. hirtellus* sp. nov.

Eine Art von ausgesprochener *Auletobius*-Gestalt, doch mit anscheinend noch flexiblem Labrum und vollständig unbedecktem Pygidium: so lässt sich diese eigenartige Rhynchitine am besten charakterisieren. Es bestände die Möglichkeit, diese Gattung unter den Tribus Rhinocartini zu stellen, abgesehen jedoch davon, dass bei den Arten der beiden hierhergehörenden Gattungen das Labrum mehr oder weniger verschmolzen und das Pygidium nur teilweise von den Flügeldecken bedeckt ist, ist auch die Rüssel- und Fühlerbildung eine andere, und in die unregelmässige Punktierung der Flügeldecken mischen sich gereihte Punkte. Es erscheint daher zweckmässig, diese Gattung einem besonderen Tribus Auletorhinini zuzuweisen, die zwischen die Auletini und Rhinocartini einzufügen wäre.

AULETORHINUS HIRTELLUS sp. nov.

Kopf fein und sehr dicht punktiert. Rüssel so lang wie Kopf and Halsschild zusammen, glänzend, gerade, zur Spitze hin leicht geradlinig verbreitert. Labrum dreieckig, an der Spitze leicht

abgerundet. Rüsselbasis mit kurzer Mittelfurche. Fühler um reichlich Schaftgliedlänge von den Augen entfernt eingelenkt. Schaft- und erstes Geisselglied gleichlang, jedes länger als breit; zweites Glied fast so lang wie Schaft- und erstes Geisselglied zusammen; drittes und viertes Glied so lang wie das erste Glied; fünftes bis siebentes Glied wenig kürzer, von annähernd gleicher Länge. Erstes und zweites Glied der Keule breiter als lang; drittes Glied mit dem Endglied so lang wie das erste und zweite Glied zusammen. Halsschild fast so lang wie breit, im basalen Drittel seitlich kräftig gerundet, nach vorn stark konisch verschmälert, vor dem Vorderrand leicht eingeschnürt. Punktierung kräftig und sehr dicht. Flügeldecken etwas weniger kräftig punktiert, mit leichter Neigung zu gereihter Anordnung. Der Nahtstreif ist bis kurz vor dem Schildchen herangeführt. Pygidium gross, dreieckig, kaum erkennbar punktiert. Hinterbrust mit Seitenteilen hochglänzend, sehr fein zerstreut punktiert, Abdomen mässig stark runzlig skulptiert.

FIG. 1. *Auletorhinus hirtellus* gen. et sp. nov., Rüsselspitze.

Färbung schwarz, oben mit Bleiglanz; die Wurzel der Geisselglieder rötlich aufgehellt; Mandibeln und Labrum rot. Behaarung greis, mässig lang niederliegend, teilweise untermischt mit längeren abstehenden Haaren. Länge, 2 millimeter.

LARAT-INSELN (*F. Muir*). British Museum of Natural History.

LASIORRHYNCHITES (PSEUDOCOENORRHINUS) CARINICOLLIS sp. nov.

Männchen.—Kopf etwas länger als breit, zylindrisch, vor der Basis ringsum schwach abgeschnürt, kräftig und sehr dicht, zum Teil runzlig punktiert. Augen mässig stark vorgewölbt, die Stirn so breit wie der Rüssel an der Basis. Rüssel so lang wie der Halsschild, schwach gebogen, bis kurz vor die Spitze oben parallelseitig, dann schwach verbreitert; die Basalhälfte mit stumpfem Mittelkiel, der seitlich von einer kräftigen Punktfurche begleitet wird; zwischen der Fühlerbasis mit breiterem Eindruck; vorn, oben, glänzend, seitlich fein gereiht punktiert. Fühler wenig vor der Rüsselmitte eingelenkt. Schaft- und erstes Geisselglied gleichlang, etwa anderthalb mal so lang wie breit, oval; zweites Geisselglied fast so lang wie Schaft- und erstes Geisselglied zusammen; drittes Glied etwas länger als

das Schaftglied; viertes und fünftes Glied so lang wie letzteres; sechstes und siebentes Glied so lang wie breit. Keule kräftig, lose gegliedert, das erste und zweite Glied breiter als lang, gleichlang; das dritte Glied mit dem kegelförmigen Endglied anderthalb mal so lang wie das erste Glied. Halsschild fast etwas länger als breit, seitlich schwach und gleichmassig gerundet, Vorderrand und Basis leicht abgeschnürt, ersterer etwas weniger breit als letztere. Punktierung kräftig und sehr dicht. Mittelkiel in der Mitte linienförmig gefurcht, die Basis und den Vorderrand nicht ganz erreichend. Schildchen dreieckig mit leicht abgestutzter Spitze. Flügeldecken reichlich anderthalb mal so lang wie breit, hinten wenig gerundet verbreitert. Skutellarstreif nur beim Weibchen deutlich, der verkürzte Randstreif kurz, weit vor den Hinterhüften mit dem vorletzten Streif vereinigt. Punktstreifen mässig stark, schwach gefurcht; Zwischenräume schmal, leicht gewölbt, nicht ausgesprochen einreihig punktiert, da verschiedene Punkte ausser der Reihe angeordnet sind, die Punkte fein, dicht stehend. Punktierung der Hinterbrust fein und verschwommen, der Seitenteile kräftiger und sehr dicht. Tibien schlank und gerade.

Weibchen.—Rüssel etwas länger als das Halsschild.

Färbung rot. Behaarung der Flügeldecken fein, anliegend, greis; des Abdomens abstehend. Länge 3.7 bis 4.8 millimeter.

NORD-BURMA, Adung Valley in 6,000 bis 12,000 Fuss Höhe (August, 1931, *Lord Cranbrook;* März, 1931, *Kingdon Ward*). British Museum of Natural History; in meiner Sammlung.

Wenn diese Art unter die Gattung *Lasiorrhynchites* gestellt würde, so dies auf Grund des beim Weibchen deutlich erkennbaren, beim Männchen angedeuteten verkürzten Skutellarstreifs, des ringsum schwach abgeschnürten Kopfes und der das Pygidium zum Teil verdeckenden Flügeldecken. Die kurze anliegende Behaarung bringt diese Art in nächste Nähe der Untergattung *Pselaphorrhynchites* unter *Coenorrhinus*. Sie ist hinter die Untergattung *Stenorhynchites* einzustellen, der sie im übrigen sehr nahe steht, macht aber auf Grund der anders gearteten Behaarung und des gebogenen Rüssels die Aufstellung einer besonderen Untergattung erforderlich, für welche der Name *Pseudocoenorrhunis* vorgesehen wurde.

TRACHELOLABUS BURMAENSIS sp. nov.

Kopf etwa doppelt so lang wie breit, von der Basis zu den Augen schwach geradlinig verbreitert. Augen verhältnismässig

klein, wenig vorgewölbt. Stirn etwa anderthalb mal so breit wie die Augen lang. Kopf der ganzen Länge nach fein gefurcht. Rüssel etwa ein und ein Viertel mal so lang wie breit, von der Basis nach vorn schwach geradlinig verbreitert. In der Mitte kräftig aufgewölbt, die Aufwölbung vorn zahnartig unterschnitten; seitlich derselben die Fühler eingelenkt. Schaftglied nicht ganz doppelt so lang wie breit; erstes Geisselglied etwas kürzer als das Schaftglied; zweites bis viertes Glied etwas länger als das Schaftglied; fünftes und sechstes Glied wenig länger als das erste Glied; siebentes Glied scheinbar zur Keule gehörig, länger als breit. Glieder der Keule kurz, quer. Halsschild etwa so lang wie breit, konisch, im basalen Teil schwach gerundet, vorn etwa halb so breit wie an der Basis. Mit feiner Mittelfurche, die zur Basis hin tiefer eingedrückt ist; beiderseits der Mitte mit je einer runden Grube. Im ganzen fein querriefelig. Schildchen quer, trapezförmig. Flügeldecken etwa ein und drei Viertel mal so lang wie breit, parallelseitig. Punktstreifen kräftig, grubenförmig, die Punkte einzeln stehend; nur der Skutellarstreif feiner punktiert. Hinten in gleicher Stärke wie vorn punktiert. Zwischenräume kaum gewölbt, schmaler als die Streifen. Unterseite fein und dicht punktiert. Alle Tibien dünn, gerade, die vorderen etwas weitläufig gezähnt. Schenkel fein gezähnt, die vorderen mit kurzem, dornförmigem Zahn.

Färbung metallischgrün, das siebente Geisselglied stahlblau, Keule schwarz. Unterseite und Flügeldecken mit kurzen anliegenden Härchen von ebenfalls glänzender olivgrüner Farbe, die sich vor und hinter der Mitte der Decken undeutlich querbindenartig gruppieren. Länge, 5 bis 6 millimeter.

NORD-BURMA, Adung Valley in 8,000 Fuss Höhe (Mai, 1931, *Kingdon Ward;* Juni, 1931, *Lord Cranbrook*). British Museum of Natural History; in meiner Sammlung.

Eine Art, die dem mir unbekannten *Trachelolabus whitei* Jekel nahe steht, sich aber der Beschreibung nach in mehrfacher Hinsicht unterscheidet. So ist der Halsschild nicht länger als breit, ohne zwei hintereinander angeordnete Quereindrücke, die Punkte der Streifen werden hinten nicht feiner und die Anordnung und Art der Behaarung scheint ebenfalls abzuweichen.

HENICOLABUS INTERMEDIUS sp. nov.

Männchen.—Kopf ohne Augen etwa anderthalb mal so lang wie breit, schwach konisch nach vorn verschmälert, hinter den

Augen mit sichtem Quereindruck, vor diesem mässig stark und dicht punktiert, die Stirn mit Mittelkiel. Augen stark halbkugelig vorgewölbt. Rüssel anderthalb mal so lang wie breit, im basalen Teil parallelseitig, von der Mitte ab nach vorn verbreitert, an der Basis stumpfwinklig abwärts gebogen, vorn fein und weitläufig, seitlich dichter und kräftiger punktiert; Fühlereinlenkungsstelle mässig aufgewölbt und schwach längsgefurcht. Fühler fast im basalen Drittel des Rüssels eingelenkt. Schaft- und erstes Geisselglied gleichlang, länger als breit; zweites und drittes Glied wenig länger; viertes bis sechstes Glied etwas länger als breit; siebentes Glied etwas breiter als lang. Erstes Glied der Fühlerkeule etwas länger als breit; zweites Glied viel breiter als lang; drittes Glied mit dem Endglied zugespitzt und fast so lang wie das erste und zweite Glied zusammen. Halsschild etwas breiter als lang, seitlich nahezu parallelseitig, von der Mitte nach vorn kräftig gerundet verschmälert; hinter dem Vorderrand mit kräftigerem, dichter punktiertem Eindruck, im übrigen feiner und weniger dicht punktiert, die Mitte mit fast unpunktiertem, breiterem Band; seitlich der Mitte beiderseits mit undeutlichem Grübchen. Schildchen etwa so lang wie breit, trapezförmig. Flügeldecken etwa ein und drei Viertel mal so lang wie breit, parallelseitig; Schultern zahnförmig erhaben, der Zahn jedoch von oben undeutlich zu sehen. Punktstreifen mässig kräftig, nach hinten zu allmählich feiner werdend, die Punkte hier um etwa ihren doppelten Durchmesser von einander entfernt stehend; Zwischenräume flach, so breit oder breiter als die Streifen, fein einreihig punktiert. Pygidium fein und nicht dicht punktiert. Abdomen fein und dicht, schwach runzlig verlaufen punktiert; Mittel- und Hinterbrust mit Seitenteilen kräftiger runzlig punktiert. Vorderschenkel sehr kräftig keulenförmig mit starkem Schenkelzahn, Vordertibien kräftig, gerade, innen leicht geschweift, kräftig und ziemlich dicht mit Höckerchen besetzt; Mittel- und Hinterbeine kürzer und schwächer, die Hintertibien in der basalen Hälfte nach innen schwach durchgebogen.

Weibchen.—Der Zahn der Vorderschenkel ist viel schwächer als beim Männchen. Färbung rot bis rotbraun, in letzterem Falle sind die Fühler und die Flügeldecken mit Ausnahme der Seiten und der Naht aufgehellt. Die Unterseite mit metallischglanzenden, anliegenden Härchen ziemlich dicht besetzt. Länge, 8 millimeter.

BORNEO: Sarawak, Mount Merinjak in 2,200 Fuss Höhe (*Bryant*, Mai, 1914). British Museum of Natural History; in meiner Sammlung.

Diese Art ist ein nächster Verwandter des *H. fausti* m. Von letzterer Art unterscheidet sie sich durch die mehr oberständige zahnartige Aufwölbung der Schultern, sodass der Zahn in der Aufsicht wenig deutlich ist. Das zweite Glied der Fühlerkeule ist quer und der Halsschild sparsamer und weniger dicht punktiert.

PARAPLAPODERUS PERAKENSIS sp. nov.

Weibchen.—Kopf mit Augen breiter als lang, die Schläfen von den Augen ab kurz parallelseitig, dann in gemeinsamem Bogen zugerundet; Augen kräftig vorgewölbt, die Stirn gut anderthalb mal so lang wie breit. Rüssel etwa so lang wie breit, seitlich kräftig eingezogen, die schmälste Stelle liegt kurz hinter der Mitte. Punktierung undeutlich. Fühler kurz vor der Basis eingelenkt. Schaftglied gut doppelt so lang wie breit; erstes Glied oval, etwas länger als breit; zweites bis viertes Glied so lang wie das erste Glied; die restlichen Glieder quer. Erstes Glied der Fühlerkeule länger als breit; zweites Glied so lang wie breit; drittes Glied breiter als lang; Endglied kurz und spitz. Halsschild fast doppelt so breit wie lang, von der kräftigen subbasalen Einschnürung ist das Scutum in starkem Bogen nach vorn verschmälert; Praesegmentalring kurz kragenförmig und nur etwa ein Fünftel so breit wie der Postsegmentalring. Oberseits ist das Scutum beiderseits der schwachen Mittelfurche abgeflächt, an der Basis seitlich schwach aufgewölbt, im ganzen kräftig und sehr dicht runzlig punktiert. Schildchen dreieckig, mit abgestutzter Spitze, hinten schwach aufgewölbt. Flügeldecken etwas länger als breit, von den Schultern ab kurz parallelseitig, dann im massiger Rundung verbreitert. Schultern aussen mit kleinem Kegelhöcker, innen und aussen gekerbt und innen ohne Höcker. Discoidalhöcker stark kegelförmig als Stachel ausgebildet; Subsuturalnerv kurz hinter der Mitte der Flügeldecken rechtwinklig nach aussen abgebogen und dann spitzwinklig wieder zur Naht verlaufend, an der Knichkstelle etwas aufgewölbt. Pygidium kräftig und sehr dicht punktiert, Abdomen feiner und dicht, Hinterbrust mit Seitenteilen kräftig runzlig. Das letzte Abdominalsegment ist seitlich schwach lappenförmig vorgezogen; Mittelbrust vor den Mittelhüften mit kräftigem, spitzem Höcker; Vorderhüften vor der Spitze vorn mit schwachem Höckerchen. Tibien gerade.

Färbung zinnoberrot; schwarz gefärbt sind: eine kleine Makel beiderseits auf dem Halsschild, der Discoidalhöcker, beziehungsweise -Stachel, die kleine subapikale Subsuturalmakel, und eine Makel auf den Hinterbrustepimeren; das grössere apikale Drittel der Hinterschenkel ist ebenfalls schwarz gefärbt. Länge, 8 millimeter.

PERAK (*Doherty*). British Museum of Natural History; in meiner Sammlung.

Leider liegt das Männchen dieser Art nicht vor, sodass nur vermutet werden kann, dass sie zur zweiten Gruppe[1] gehört und hier hinter *P. breviceps* m. einzuordnen ist. Die sparsame Fleckenzeichnung, der scharf stachelförmig ausgebildete Discoidaldorn bei nur schwacher Schulterbewehrung machen die Art unter den Verwandten leicht kenntlich.

TOMAPODERUS DOHERTYI sp. nov.

Männchen.—Kopf mit Augen etwa ein und ein Viertel mal so lang wie breit, von den Augen in leichtem Bogen nach hinten zu konisch verschmälert. Stirn durch eine Querfurche vom Rüssel abgesetzt, von der zwei kleine flatenartige Furchen zur Stirn ausstrahlen, die Stirn doppelt so breit wie die Augen lang. Augen mässig stark vorgewölbt. Rüssel breiter als lang, von der Basis nach vorn verbreitert, seitlich vereinzelt punktiert. Fühler im basalen Drittel eingelenkt. Schaftglied keulenförmig, gut doppelt so lang wie breit; erstes Geisselglied oval, länger als breit; zweites bis viertes gleichlang, verkehrt kegelförmig, so lang wie das erste Glied; die restlichen Glieder breiter als lang. Erstes Glied der Fühlerkeule so lang wie breit; zweites Glied breiter als lang; drittes Glied mit dem Endglied so lang wie das erste Glied. Halsschild breiter als lang, leicht gerundet und stark konisch von der subbasalen Querfurche nach vorn verjüngt. Praesegmentalring kragenförmig abgesetzt; Scutum mit mässig starker Mittelfurche und seitlich derselben mit mehr oder weniger kräftigem Eindruck, unpunktiert und nur stellenweise mit leicht gekräuselter Sculptur. Schildchen dreieckig mit breit abgerundeter Spitze. Flügeldecken kaum ein und ein Viertel mal so lang wie breit, im basalen Teil nahezu parallelseitig, nach hinten zu schwach gerundet verbreitert; Punktstreifen mässig stark, die Punkte um etwa ihren Durchmesser oder etwas weniger von einander entfernt stehend, nicht furchig vertieft; Zwischenräume breit, flach, gleichmässig dicht unre-

[1] Stett. Ent. Ztg. 87 (1926) 43.

gelmässig punktiert. Pygidium kräftig und ziemlich dicht punktiert. Punktierung der Unterseite sparsam. Schultern mit seitlich vorstehendem Tuberkel. Tibien gerade.

Weibchen.—Der Halsschild ist weniger konisch und seitlich mehr ausladend gerundet geformt, der seitlich der Mittelfurche des Scutums gelegene Eindruck gestaltet sich mehr ringförmig und schliesst eine schwach aufgewölbte Partie ein.

Färbung gelbrot; schwarz mit blauem Schein ist der Kopf unterseits, eine runde Makel auf der Stirn (bisweilen fehlend oder undeutlich), Halsschild-Unterseite, mit Ausnahme der Hüften, oberseits eine längliche Mittelmakel im apikalen Teil gelegen und kurz vor der subbasalen Querfurche aufhörend; das Schildchen, ein breites basales Querband, hinter dem Schildchen weiter ausgedehnt, ein breites an der Naht unterbrochenes Querband auf der Mitte der Flügeldecken und schliesslich die Spitze der Flügeldecken in weiterem Umfang. Der schmale Rand der Flügeldecken, die Mittel- und Hinterbrust mit Seitenteilen und das Abdomen mit Ausnahme des Randes ebenfalls von schwarzer Färbung. Pygidium mit zwei schwarzen Flecken. Länge, 6.5 bis 7 millimeter.

OST-INDIEN, Manipur (*Doherty*). British Museum of Natural History; in meiner Sammlung.

Die erste bekannt gewordene *Tomapoderus*-Art mit Fleckenzeichnung und damit ausser durch den breiten, beim Männchen kräftig konisch verjüngten Halsschild hierdurch leicht zu erkennen. Die schöne Art möge ihrem Entdecker zu Ehren benannt sein.

CYCNOTRACHELUS FLAVONOTATUS sp. nov.

Männchen.—Kopf etwa doppelt so lang wie breit, leicht gerundet konisch, die Stirn reichlich anderthalb mal so breit wie die mässig stark vorgewölbten Augen lang. Hals erheblich länger als der Kopf, dicht ringförmig geriefelt. Rüssel gut doppelt so lang wie an der Spitze breit und hier viel breiter wie im basalen Teil, vor der Mitte an der Fühlereinlenkung kräftig aufgewölbt, im basalen Teil mit scharfen Randfurchen, die divergierend zur Stirn auflaufen. Schaftglied stark, anderthalb mal so lang wie breit; erstes Geisselglied wenig länger als breit; zweites Glied etwas länger als das erste; drittes bis fünftes Glied fast doppelt so lang wie das erste Glied; sechstes und siebentes Glied quer. Erstes und zweites Glied der Fühlerkeule gleichlang, jedes anderthalb mal so lang wie breit; drittes Glied

quer; Endglied spitz ausgezogen, gebogen. Halsschild viel länger als breit, seitlich stark konkav gerundet, kräftig querriefelig, hinter dem Praesegmentalring mit halbkugelförmiger Aufwölbung. Flügeldecken etwas länger als breit, fast parallelseitig. Punktstreifen ziemlich kräftig; Zwischenräume breiter als die Streifen, leicht gewölbt, glänzend, unpunktiert. Die Flügeldecken tragen folgende Tropfenflecke: Auf dem zweiten Zwischenraum befindet sich im basalen Viertel eine Makel, die auf der rechten Flügeldecke einer L und auf der linken dem Spiegelbild einer solchen entspricht; auf dem gleichen Zwischenraum auf der Mitte eine länglich ovale Makel, auf dem dritten und vierten Zwischenraum in der Länge des basalen Viertels je eine sich nach hinten keilförmig verbreiternde Makel; auf der Mitte der Flügeldecken ausser der bereits erwähnten auf dem zweiten Zwischenraum je eine weitere auf dem vierten, sechsten und achten Zwischenraum, von denen diejenige auf dem vierten Zwischenraum etwas schmaler und mehr nach hinten, die anderen wieder in etwa gleicher Höhe mit der inneren Tropfenmakel angeordnet sind, und diejenige auf dem achten Zwischenraum mehr strichförmig ausgebildet ist. Vor der Spitze der Flügeldecken hat dann der zweite und vierte Zwischenraum eine grosse gemeinsame Makel und schliesslich sind die Schultern gelb gefärbt.

Weibchen.—Halsschild breiter als lang, mit tief abgeschnürtem Praesegmentalring; die Mitte der Länge nach gefurcht und die etwas schwächere Aufwölbung hinter dem Praesegmentalring ringsum von einer Furche begrenzt.

Färbung bräunlichrot mit den vorstehend näher beschriebenen dottergelben Tropfenzeichnungen auf den Flügeldecken. Länge, 6.8 bis 13 millimeter.

BURMA, Ruby Mines; Momeit. British Museum of Natural History; in meiner Sammlung.

Dadurch, dass beim Weibchen der Praesegmentalring des Halsschilds kräftig abgeschnürt ist, trennt sich die Art von *flavotuberosus* Jekel and müsste auf Grund dieses Merkmals zum Formenkreis *satelles* Pascoe und *flavoguttatus* m. gezogen werden, die jedoch auf dem achten Zwischenraum der Decken ungemakelt sind. Die Art steht also zwischen *flavotuberosus* und *satelles;* und auch recht glücklich, weil beide Arten glänzende, unpunktiert Zwischenräume besitzen, im Gegensatz zu *flavoguttatus* m. aus Indien and China.

EUOPS IGNITA sp. nov.

Weibchen.—Kopf kurz, hinter den Augen mit feiner, punktierter Einschnürungsfurche, sonst unpunktiert. Augen wenig vorgewölbt. Rüssel etwa anderthalb mal so lang wie breit, von der Basis geradlinig nach vorn verbreitert, sehr fein und weitläufig punktiert. Fühler basal eingelenkt. Schaftglied nicht ganz doppelt so lang wie breit; erstes Geisselglied noch etwas kräftiger als das Schaftglied, oval; die nächsten Glieder schwächer; Zweites Glied so lang wie das erste Glied; drittes Glied kürzer; viertes Glied fast so lang wie das zweite Glied; die restlichen Glieder quer. Fühlerkeule fast so lang wie die Geissel; erstes Glied so lang wie breit; zweites Glied etwas kürzer; drittes Glied mit dem Endglied etwas länger als das erste Glied. Halsschild breiter als lang, fast gerandlinig konisch, stark nach vorn verschmälert, fein und mässig dicht punktiert. Schildchen viereckig, etwa so lang wie breit. Flügeldecken etwa ein und ein Viertel mal so lang wie breit, von den Schultern ab fast geradlinig und nur schwach zur Mitte hin verschmälert, dann in gleichmässigem Bogen zur Spitze verrundet. Punktstreifen mässig stark, die Punkte schmal getrennt; Zwischenräume kaum gewölbt, sehr fein einreihig punktiert. Pygidium fein und sehr dicht punktiert, Abdomen weniger dicht, Hinterbrust mit Seitenteilen ziemlich dicht punktiert. Hintertibien im apikalen Drittel ziemlich kräftig einwärts gebogen.

Färbung stahlblau, Abdomen und Pygidium mit leichtem Bronzeschein; Flügeldecken tief metallisch rot gefärbt; Fühler pechbraun. Länge, 2 bis 2.5 millimeter.

BURMA, Ruby Mines (*Doherty*). British Museum of Natural History; in meiner Sammlung.

Die Art ist nahe verwandt mit *Euops tonkinensis* m. und mit *gardneri* Marshall.[2]

EUOPS (SUNIOPS) SUBDENTATA sp. nov.

Männchen.—Kopf kurz, hinter den Augen nur mit vereinzelten feinen Punkten besetzt. Rüssel anderthalb mal so lang wie breit, von der Seite gesehen, zur Spitze verjüngt. Fühler in der Nähe der Rüsselbasis eingelenkt. Schaft- und erstes Geisselglied gleichlang, etwa anderthalb mal so lang wie breit, das Schaftglied etwas keulenförmig, das erste Geisselglied oval; zweites und viertes Glied wenig kürzer als das erste Glied, verkehrt

[2] Philip. Journ. Sci. 50 (1933) 114.

kegelförmig, viel schwächer; fünftes und sechstes Glied noch länger als breit; siebentes Glied so lang wie breit. Erstes Glied der Keule etwas länger als breit; zweites Glied so lang wie breit; drittes Glied mit dem Endglied so lang wie das erste Glied. Halsschild etwas breiter als lang, seitlich kräftiger gerundet, die grösste Breite im basalen Drittel. Punktierung fein, weitläufig, seitlich etwas kräftiger, die Zwischenstege oberseits leicht querriefig verlaufend. Schildchen quer, hinten leicht gerundet. Flügeldecken so lang wie breit, von den Schultern geradlinig nach hinten verschmälert, an der Spitze einzeln gerundet. Punktstreifen mässig kräftig, hinten kaum feiner werdend; Zwischenräume breiter als die Streifen, nach innen zu etwas abfallend, fein weitläufig, einreihig punktiert. Vordertibien wenig schlank, nur im apikalen Drittel leicht gebogen, im übrigen Teil fast gerade, innen fein gezähnt. Die äussere Leiste gezähnt: Ein Endzahn kräftiger; vier weitere feiner, doch etwas kräftiger als die Innenzähnelung, der zweite und dritte Zahn um etwa Zahnhöhe, die übrigen um etwa anderthalb Zahnhöhe von einander entfernt stehend; in etwas weiterem Abstand folgt ein kleines, wenig auffälliges Zähnchen. Mittel- und Hintertibien gedrungener, gerade. Pygidium fein und dicht punktiert. Abdomen sehr fein und weitläufig eingestochen punktiert.

Färbung schwarz; Kopf, beim Männchen auch der Halsschild, Unterseite und Pygidium, Schildchen und Schultern metallischgrün, zum Teil auch die Schenkel metallischgrün überhaucht; Flügeldecken leuchtend blau; Fühler braun. Länge, 2.5 millimeter.

LARAT (*Muir*). British Museum of Natural History; in meiner Sammlung.

Die Vorder- und Mittelschenkel sind nur fein gezähnt, die Hinterschenkel jedoch etwas kräftiger. Beide Geschlechter haben nur einen Enddorn an den Tibien, die Vordertibien des Männchens nur einen kegelförmigen Fortsatz.

Diese Art steht *Euops aerosa* Pascoe sehr nahe. Während aber bei letzterer der Kopf dicht punktiert und zwischendurch fein punktuliert ist, ist er bei unserer Art glänzend und weitläufig punktiert ohne Zwischenpunktierung. Auch ist bei unserer Art der Halsschild kürzer und weniger deutlich quergeriefelt; die Zwischenräume der Flügeldecken weniger abfallend und aussen weniger kielartig abschliessend, auch nicht querrunzlig wie bei *aerosa* skulptiert. Die Vordertibien des Weibchens sind gedrungener gebaut.

OTIDOGNATHUS SQUAMIGER sp. nov.

Männchen.—Kopf fein und weitläufig punktiert; Stirn mit grubenförmigem Eindruck und an der schmälsten Stelle etwa ein Drittel so breit wie der Rüssel vor der Basis. Rüssel so lang wie der Halsschild, durchaus gerade, von der Fühlereinlenkung nach vorn verschmälert und an der Spitze wiederum verbreitert; im basalen Teil mit feinem Mittelkiel und feiner seitlicher Punktierung, vorn auf zwei Drittel der Länge mit einer Doppelreihe kräftiger Höckerzähne. Fühler-Schaft so lang wie die Geissel; erstes Geisselglied etwa anderthalb mal so lang wie breit; zweites Glied wenig kürzer; drittes Glied noch deutlich etwas länger als breit; viertes und sechstes Glied so lang wie breit; fünftes Glied breiter als lang. Basalglied der Fühlerkeule an der Spitze so breit wie lang. Halsschild länger als breit, von der Basis nach vorn gleichmässig gerundet verschmälert, der Vorderrand nicht zylindrisch abgesetzt. Oberseite mässig stark und dicht punktiert, jeder Punkt mit einer Gruppe Schuppen besetzt. Schildchen dreieckig, länger als breit, sparsam beschuppt. Flügeldecken von den Schultern geradlinig nach hinten verschmälert. Punktstreifen linienfömig eingerissen; Zwischenräume flach, mässig stark und dicht unregelmässig punktiert, jeder Punkt trägt eine Gruppe Schuppen. Pygidium hinten abgestutzt. Abdomen in der Mitte fein, seitlich kräftiger und dichter punktiert. Penis an der Spitze mit zwei Zähnchen.

Färbung bräunlichrot; Kopf, Rüssel, Fühler, Kniee, Tarsen, Halsschild-Oberseite und Spitze der Fügeldecken schwärzlich; Schenkel und Tibien rot. Oberseite zerstreut, Unterseite mit Ausnahme der Mitte des Abdomens dichter beschuppt. Länge, 11 millimeter.

PHILIPPINEN, Nord-Palawan, Binaluan (November bis Dezember, 1913, *Boettcher*). In meiner Sammlung.

Unter den mir bisher bekannt gewordenen Arten auffällig durch die auch oberseitige Beschuppung des Körpers. In dieser Hinsicht dürfte die Art dem *O. ursinus* Faust nahe stehen, von welcher sie sich durch spärlichere Punktierung des Kopfes, nicht ausgesprochen zweireihige Beschuppung der Interstitien, andere Färbung und geringere Grösse unterscheidet. Wie mir Herr Dr. Günther am Zoologischen Museum zu Dresden mitteilt, ist es die einzige nicht auf Neu-Guinea heimische Art, die eine derartige Schuppenbekleidung aufweist.

LAOGENIA AFFINIS sp. nov.

Rüssel gut halb so lang wie der Halsschild, fast gerade, undeutlich gebogen, zylindrisch, glänzend, sehr fein und dicht punktiert, der Rand der verstärkten Basalpartie seitlich mit einer von einer Schuppenreihe begleiteten Furche, die im Bogen zur Stirn aufläuft. Schaft kurz, den Hinterrand der Augen erreichend; erstes Geisselglied so lang wie breit; zweites Glied am längsten, doppelt so lang wie breit; die restlichen Glieder fast so lang wie breit; Basalglied der Fühlerkeule etwas breiter als lang, das tomentierte Spitzenteil halb so lang wie das Basalglied. Halsschild reichlich anderthalb mal so lang wie breit, so lang wie die Flügeldecken, parallelseitig, vorn leicht zugerundet und der Vorderrand abgeschnürt; Punktierung kräftig und sehr dicht, mit ziemlich kräftiger Mittelfurche. Schildchen undeutlich. Flügeldecken parallelseitig, hinten leicht zugerundet. Punktstreifen kräftig, furchenartig vertieft; Zwischenräume schmal kielförmig. Pygidium länger als breit, dreieckig; kräftig längsgereiht punktiert. Hinterschenkel die Spitze des Pygidiums erreichend. Unterseite und die apikale Hälfte der Schenkel kräftig und dicht punktiert. Tibien innen nicht gekerbelt.

Färbung pechbraun; Kopf, Halsschild und Schenkel fast schwarz; Flügeldecken rotbraun und ringsum dunkel gesäumt. Halsschild mit zerstreut angeordneten Schuppen besetzt, Basis des Rüssels in der Mitte und seitlich mit je einer Doppelreihe Schuppen bekleidet, die zur Stirn auflaufen, die abwechselnden Zwischenräume der Flügeldecken und die Unterseite gereiht beschuppt, die Schuppen auf den Decken kurz abstehend. Länge, 4.5 millimeter.

PHILIPPINEN, Nord-Palawan, Binaluan (November bis Dezember, 1913, *Boettcher*). In meiner Sammlung.

Der in der Grösse sehr veränderlichen *Laogenia episternalis* Heller ähnlich, an dem viel kürzeren Rüssel sofort kenntlich.

MYOCALANDRA FUSCA sp. nov.

Augen kaum vorgewölbt. Rüssel im apikalen Drittel bis Viertel stumpfwinklig abwärts gebogen, im vorderen Teil durchaus gerade und zylindrisch, hier fein gereiht punktiert; vor der Fühlereinlenkung knotenförmig verstärkt und zur Basis verjüngt, die Seiten kielartig zur Mitte der Stirn auflaufend. Fühler nur um wenig mehr als die Dicke des Schaftes von den

Augen entfernt eingelenkt. Schaft kräftig und breit, kurz, den Hinterrand der Augen erreichend; erstes Geisselglied kaum so lang wie breit; zweites Glied am längsten etwa anderthalb mal so lang wie breit; die restlichen Glieder quer. Basalglied der Fühlerkeule länger als breit; der tomentierte Spitzenteil halb so lang wie der Basalteil. Halsschild kaum länger als breit, in der basalen Hälfte parallelseitig, dann nach vorn leicht gerundet verschmälert; Vorderrand abgeschnürt; zur basis mässig und kurz gerundet verschmälert; kräftig und sehr dicht runzlig gekörnt skulptiert mit verkürztem Mittelkiel. Schildchen so lang wie breit, viereckig. Flügeldecken kaum ein und ein Viertel mal so lang wie breit, trapezförmig, seitlich undeutlich gerundet. Punktstreifen kräftig, die Zwischenräume sehr schmal. Hinterschenkel die Spitze des Pygidiums kaum überragend. Vordertibien innen gekerbt, die Mittel- und Hintertibien einfach.

Färbung einfach pechbraun. Flügeldecken und Pygidium mit kurz abstehenden Börstchen bekleidet. Länge, 37 millimeter.

PHILIPPINEN, Luzon, Limay (Oktober, 1914, *Boettcher*). In meiner Sammlung.

Der stumpfwinklig abwärts gebogene Rüssel würde die Art in die Gattung *Laocalandra* Heller verweisen, der nicht gebogene Rüssel und die innen nicht gekerbten Mittel- und Hintertibien sprechen jedoch dagegen.

ILLUSTRATION

TEXTFIGUR 1. *Auletorhinus hirtellus* gen. et sp. nov., Rüsselspitze. 523

NEW OR LITTLE-KNOWN TIPULIDÆ FROM EASTERN ASIA (DIPTERA), XXIV[1]

By CHARLES P. ALEXANDER

Of Amherst, Massachusetts

THREE PLATES

The crane flies considered in this report are chiefly from the mountains of Szechwan Province, western China, where they were collected by the Rev. Mr. David C. Graham. Smaller series discussed herewith are from Formosa, collected by Mr. J. Linsley Gressitt; from Japan, by Prof. Satoru Kuwayama; and from Kashmir, by Miss Vivien R. Hutchinson. The types of the species included in the Graham material are preserved in the United States National Museum, the remaining types in my own collection. My deepest thanks are extended to the above-mentioned collectors for this continued aid in making known the vast tipulid fauna of the area in question. Two species of the allied family Trichoceridæ are described in this paper.

TRICHOCERIDÆ

TRICHOCERA RETICULATA Alexander.

Trichocera reticulata ALEXANDER, Philip. Journ. Sci. **50** (1933) 129–130.

Known hitherto only from the unique type, taken on Mount Omei, Szechwan, July 18, 1931, by George M. Franck.

Two females, Wei Chow, Szechwan, 65 miles northwest of Chengtu, altitude 9,000 to 12,500 feet, August 15, 1933 (*Graham*).

TRICHOCERA SAPPORENSIS sp. nov. Plate 1, fig. 1; Plate 2, fig. 25.

Belongs to the *maculipennis* group; general coloration of mesonotum dark brownish gray, the præscutum with four darker brown stripes; knobs of halteres dark brown; legs with femora brown, the outer ends passing into dark brown; wings yellowish subhyaline, with a heavy brown pattern, including a broken brown crossband at near midlength of the outer radial field;

[1] Contribution from the entomological laboratory, Massachusetts State College.

abdomen, including the hypopygium, dark brown; male hypopygium with the dististyle cylindrical, without basal armature.

Male.—Length, about 6.5 millimeters; wing, 7.

Rostrum dark gray; palpi black. Antennæ black throughout. Head dark brownish gray.

Mesonotal præscutum dark brownish gray, with four darker brown stripes, the intermediate pair clearly defined, separated from one another by a clear ground vitta that is more than one-half as wide as either stripe; lateral stripes broader but less clearly defined; posterior sclerites of mesonotum dark brown, pruinose. Pleura dark brown, pruinose. Halteres elongate, the stem yellow, the knob dark brown. Legs with the coxæ brown; trochanters brownish yellow; femora brown, the outer ends passing into dark brown; tibiæ and tarsi brownish black to black. Wings (Plate 1, fig. 1) with the ground color yellowish subhyaline, the costal margin more saturated; a relatively heavy brown pattern, including spots at origin of Rs, Sc_2, a stigmal area at R_2, along cord and outer end of cell 1st M_2; a spot at tip of vein 2d A in cell 1st A; an outer, more or less broken, brown band crossing the outer medial field at near midlength of the cells; veins brown. Venation: Sc_1 ending just beyond R_2; cell R_3 a little constricted just before outer end; m-cu about one-half its length before fork of M_{3+4}.

Abdomen, including hypopygium, dark brown. Male hypopygium (Plate 2, fig. 25) with the mesal lobes of basistyle, *b*, contiguous on midline. Dististyle, *d*, rather short-cylindrical, without basal tubercle; mesal face with abundant delicate setulæ, distributed throughout the length.

Habitat.—Japan (Hokkaido).

Holotype, male, Sapporo, Ishikari, September, 1922 (*Kuwayama*).

The relationship of this fly to other members of the *maculipennis* group in eastern Asia is shown by the accompanying key.

Key to the species of the maculipennis group (genus Trichocera) in eastern Asia.

1. Femora brown or brownish yellow, with a subterminal brown or brownish black ring, the extreme tip pale yellow to whitish; in cases, only the posterior femora are evidently so patterned ..... 2.
   Femora without a dark ring near apex, the actual tip dark ..... 5.
2. Wing pattern abundantly reticulated, including a series of dots and transverse dashes in cells C, Sc_1, all outer cells, and in cells Cu and 1st A. (Western China.) ..... *reticulata* Alexander.
   Wing pattern not reticulated ..... 3.

3. Wing pattern light, usually without markings across outer radial field or spots in cell 2d A; dark areas not involving outer medial field; at most, a single dark spot in cell 1st A. (Western Palæarctic Region.) *maculipennis* Meigen.

Wing pattern heavy, including a broken outer band that crosses the radial and medial fields; two dark spots in cell 1st A ..... 4.

4. Wings with the ground color nearly hyaline; second dark spot in cell 1st A not touching vein 2d A; male hypopygium without basal tubercle on dististyle. (Himalayan Region.) ..... *punctipennis* Brunetti.

Wings strongly tinged with yellow, especially along costal border; second dark spot in cell 1st A touching vein 2d A; male hypopygium with a basal tubercle on dististyle. (Western China.) *szechwanensis* sp. nov.

5. General coloration of mesonotum brown; abdominal segments brown, ringed with yellow. (Formosa.) ..... *arisanensis* Alexander.

General coloration of mesonotum dark gray or brownish gray; abdomen uniformly darkened or with the segments merely pruinose at outer end ..... 6.

6. Male hypopygium without basal tubercle on dististyle; wing pattern heavy, in male including a band across outer radial field. (Northern Japan.) ..... *sapporensis* sp. nov.

Male hypopygium with a small basal tubercle on dististyle; wing pattern light, in male without a band across outer radial field. (Japan.) *pictipennis* Alexander.

I have omitted *Trichocera ocellata* Walker from the above key because of lack of data on certain of the points used in the key structure. The species should be readily distinguished from all species keyed above by the partly ocelliform nature of the wing pattern.

TRICHOCERA SZECHWANENSIS sp. nov. Plate 1, fig. 2; Plate 2, fig. 26.

Belongs to the *maculipennis* group; general coloration gray, the præscutum with four, narrow, dark brown stripes; femora brownish yellow, the tips of fore and middle femora darkened, the posterior femora with a subterminal dark ring; wings strongly suffused with yellow, heavily patterned with brown; male hypopygium with a small basal tubercle on mesal face of dististyle.

Male.—Length, about 6.5 to 7.5 millimeters; wing, 7.5 to 9.

Female.—Length, 7 to 8.5 millimeters; wing, 7.5 to 10.

Rostrum and palpi black. Antennæ with scape brownish black; pedicel more reddish brown; flagellum black. Head gray.

Mesonotal præscutum gray with four narrow and distinct dark brown stripes, the intermediate pair separated by a ground line that is nearly as wide as the stripe itself; posterior sclerites of notum gray. Pleura gray. Halteres yellow, the knobs dark

brown. Legs with the coxæ brownish gray; trochanters obscure yellow; femora brownish yellow, the tips dark brown; on posterior femora the dark rings distinctly subterminal, with narrow but conspicuous yellow tips; on fore and middle femora the dark rings are apical or virtually so; tibiæ and basitarsi light yellowish brown; outer tarsal segments passing into brownish black. Wings (Plate 1, fig. 2) with the ground color strongly suffused with yellow, more saturated in the costal portion; an unusually heavy brown pattern, including areas at origin of Rs, Sc_2, along cord and outer end of cell 1st M_2, and a broad, nearly unbroken, oblique band across the outer radial and medial fields; in cases, the latter band appears double, with pale centers; in addition to the above, a series of dark marginal spots at ends of all longitudinal veins, the largest at 2d A, contiguous with the tip of the vein; in the more heavily patterned specimens, especially females, the entire caudal border of cell 1st A is uninterruptedly darkened; in still other cases with transverse dashes in basal portions of cells R_4 and R_5, extending from near the fork of vein R_{2+3+4} to m; veins pale, darker in the clouded areas. A series of trichia at near midlength of vein 2d A, lacking at both ends. Venation: m-cu close to fork of M_{3+4}.

Abdomen dark brown, the caudal borders of segments in female narrowly paler; hypopygium dark. Male hypopygium (Plate 2, fig. 26) with the dististyle, *d*, cylindrical, on mesal face at base with a small tubercle.

Habitat.—China (Szechwan).

Holotype, male, Chengtu, altitude 1,800 feet, February 20, 1933 (*Graham*). Allotopotype, female, February 28, 1933. Paratopotypes, several males and females, February 20 to March 13, 1933; paratype, 1 male, Kwanhsien, altitude 2,000 to 4,000 feet, May 15 to 31, 1933 (*Graham*).

The nearest allies of the present fly are *Trichocera pictipennis* Alexander and *T. punctipennis* Brunetti. The characters separating these species and other regional members of the group are shown by the key given in connection with the preceding species. Several of the specimens in the type series are much smaller than the holotype and allotype chosen as being representative of the species, but the entire series appears to present a single form.

TIPULIDÆ

TIPULINÆ

TIPULA (VESTIPLEX) OPTANDA sp. nov. Plate 1, fig. 3; Plate 2, figs. 27 and 28.

General coloration of mesonotum yellow, with four grayish brown stripes that are narrowly bordered by dark brown, the intermediate pair confluent at anterior ends; capillary median lines on head and on mesonotum from suture caudad to base of abdomen; knobs of halteres dark brown; femora brownish yellow, the tips blackened, preceded by a vague, more yellowish ring; wings relatively narrow, marmorate with cream-colored and darker areas; basal abdominal tergites yellow, trivittate with brown; fifth and succeeding abdominal segments black; male hypopygium with a small apical spine on basistyle; mesal appendage of basistyle black, forked at tip.

Male.—Length, about 17 millimeters; wing, 20.

Frontal prolongation of head yellow, darker laterally; nasus long and slender; palpi dark. Antennæ (male) relatively long, if bent backward extending approximately to base of abdomen; scape and pedicel yellow; first flagellar segment light brown; remaining flagellar segments black, the extreme apex of the more proximal segments a trifle paler; longest verticils very nearly equal in length to the segments. Head chiefly covered with a golden yellow pollen; central portion of posterior vertex with a conspicuous brown streak.

Mesonotal præscutum yellow with four grayish brown stripes that are narrowly bordered by dark brown, the intermediate pair confluent at anterior ends; scutal lobes with two confluent dark brown areas on outer portion; scutellum and mediotergite golden yellow; a capillary, dark brown, median vitta extends from the suture to the base of abdomen, slightly interrupted at the sutures. Pleura yellow, variegated with darker on the anepisternum. Halteres brownish yellow, the knobs dark brown. Legs long and slender; coxæ and trochanters yellow; femora brownish yellow basally, passing into black on outer two-thirds, the tips broadly black, preceded by a vague, more yellowish ring; tibiæ and tarsi black. Wings (Plate 1, fig. 3) relatively narrow; ground color brown, variegated by cream-colored and darker areas; cell Sc more darkened, pale beyond origin of Rs;

a dark mark in bases of cells R and M; a small inclosed white spot at proximal end of stigma; apical cells of wing uniformly darkened; cell 2d A variegated by pale at base and at outer end; veins dark brown. Venation: R_{1+2} entire but pale, with trichia only at extreme proximal end; cell 1st M_2 relatively long, its outer end somewhat pointed by the obliquity of m.

Abdominal tergites yellow, with a broad median stripe and much narrower, sublateral, brown stripes; fifth and succeeding segments uniformly black; basal sternites yellow. Male hypopygium (Plate 2, fig. 27) with the tergite, 9*t*, fused with sternite, 9*s*, on its cephalic portion. Tergite (Plate 2, fig. 28, 9*t*) with the outer lobes relatively long and slender, fleshy and conspicuously setiferous, divergent; caudal margin of tergite with a broad U-shaped notch; on ventral surface of tergite, on either side, with a compressed black plate, the apex of which is microscopically serrulate. Basistyle at apex (Plate 2, fig. 28, *b*) produced into a small, slender, straight or gently curved spine, much more reduced and delicate than in most species of the subgenus; on mesal-posterior portion of basistyle a larger curved black hook; immediately above this point and apparently arising from the ninth sternite, a long, slender, curved, black rod (Plate 2, fig. 28, *m*), decussate with its mate across the median line, at apex split into two branches; outer branch a little longer than the lower one; outer margin and surface of this rod with long, delicate, pale setæ. Dististyles as shown (Plate 2, fig. 27, *id, od*). Eighth sternite unarmed with setæ.

Habitat.—China (Szechwan).

Holotype, male, Kwanhsien, altitude 2,000 to 4,000 feet, May 15 to 31, 1933 (*Graham*).

The nearest ally of this fly is undoubtedly *Tipula* (*Vestiplex*) *parvapiculata* Alexander, of northern Formosa, which has the same reduced spine on the basistyle of the male hypopygium and with the mesal appendage of the ninth sternite of somewhat similar form though pale yellow in color. The Formosan species is separated by the much shorter antennæ, details of wing pattern, and the structure of the male hypopygium.

TIPULA (VESTIPLEX) IMMOTA sp. nov. Plate 1, fig. 4; Plate 2, fig. 29.

General coloration of mesonotum brownish yellow, the præscutum with four conspicuous brown stripes, the intermediate pair narrowly confluent in front; antennæ (male) elongate; head and posterior sclerites of mesonotum with a narrow brown

capillary vitta; wings whitish subhyaline, marmorate with pale and darker brown areas; basal abdominal segments yellow, the outer segments black; male hypopygium with the basistyle produced into a curved black spine; inner dististyle narrow, the tip obtusely rounded.

Male.—Length, 12 to 13 millimeters; wing, 13 to 15; antenna, 5 to 6.

Frontal prolongation of head yellow; nasus elongate; a narrow dark line on side of prolongation; palpi brownish black. Antennæ (male) elongate; basal three segments light yellow; flagellar segments bicolorous, the basal enlargement and adjoining portions of the individual segments dark, the remainder brownish yellow; in the paratype male the segments are more uniformly darkened, with only the outer ends of the segments restrictedly yellow. Head yellow, with a narrow, capillary, brown median vitta.

Mesonotal præscutum brownish yellow, with four conspicuous brown stripes that are not bordered by darker but are narrowly margined with clearer yellow outside the limits of the stripes; intermediate pair very narrowly confluent at anterior margin; scutal lobes brownish yellow, each with two conspicuous brown areas; scutellum and mediotergite brownish yellow, with a narrow brown median line that is narrowly interrupted on posterior portion of the scutellum. Pleura yellow, more grayish on the ventral anepisternum and sternopleurite. Halteres yellow, the knobs dark brown, their tips paler. Legs with the coxæ and trochanters yellow; femora brownish yellow, the tips conspicuously blackened, preceded by a vaguely brighter, clearer yellow annulus; tibiæ dark brown, passing into black; tarsi black. Wings (Plate 1, fig. 4) whitish subhyaline, variegated by pale brown and darker brown areas; the darker markings include major areas in bases of cells R and M, together with the stigma and a confluent cloud on anterior cord; paler brown areas cloud most of the wing disk, including the entire wing tip except a vague brightening in outer end of cell R_5; veins brown. Venation: R_3 rather strongly upcurved, a little less so in the type than in the paratype (which is figured).

Basal abdominal segments yellow, the first segment and basal ring of second tergite darkened medially; sixth and succeeding segments black. Male hypopygium (Plate 2, fig. 29) with the basistyle, *b*, entirely cut off from sternite, 9*s*, by a suture; poste-

rior end of basistyle produced into an acute blackened spine that is directed caudad, dorsad, and slightly mesad. Ninth tergite, 9*t*, transverse, the caudal margin with a broad U-shaped emargination, the border of this notch heavily blackened, especially the nearly acute sublateral lobes; sublateral lobes separated from paler outer lobes by small V-shaped notches; tergite not divided medially by membrane, but restrictedly paler in color at midline, and the midregion of the blackened margin with a microscopic split; caudal border of tergite with conspicuous setæ. Outer dististyle, *od*, a narrow dusky lobe with abundant coarse setæ. Inner dististyle, *id*, unusually narrow, the tip obtuse, the face with two low blackened lobes; outer margin of style with abundant erect yellow setæ.

Habitat.—China (Szechwan).

Holotype, male, Kwanhsien, altitude 2,000 to 4,000 feet, May 15 to 31, 1933 (*Graham*). Paratopotype, male.

The present fly is readily told from other small species of the subgenus having the basistyle produced into a simple acute spine and with the wings darkened in the proximal ends of cells R and M, by the elongate antennæ of the male and the structure of the male hypopygium, notably the undivided tergite and the narrow, obstusely pointed, inner dististyle.

TIPULA (OREOMYZA) COXITALIS sp. nov. Plate 1, fig. 5; Plate 2, figs. 30 and 31.

General coloration yellow, the præscutum with four narrow brownish stripes, the intermediate pair narrowly divided by a pale line; antennal flagellum bicolorous; tips of femora darkened; wings yellow, the prearcular and subcostal regions brighter yellow; disk of wing variegated by dark and pale brown clouds; outer end of cell 1st M_2 pointed; male hypopygium with the basistyle entire, produced caudad into a long powerful arm; a pencil of reddish setæ on either side of median line of ninth sternite.

Male.—Length, about 15 to 18 millimeters; wing, 16 to 19.

Female.—Length, 18 to 20 millimeters; wing, 16 to 18.5.

Frontal prolongation of head brownish yellow; nasus long and conspicuous; palpi dark brown, the incisures paler. Antennæ (male) of moderate length, if bent backward extending nearly to root of halteres; scape, pedicel, and first flagellar segment yellow; succeeding flagellar segments bicolorous, yellow, with the basal enlargements of the individual segments black; outer segments more obscured, but retaining the bicolorous nature to the end; longest verticils subequal in length to the segments.

Head buffy, with a very faint brown median line; posterior orbits very narrowly pale.

Mesonotal præscutum yellow, with four narrow brownish stripes, the intermediate pair narrowly separated except at extreme posterior end by a capillary pale vitta; mesal edges of anterior third of intermediate stripes a little darker than the corresponding outer edges; small brown spots in humeral area; scutum yellow, each lobe variegated by darker yellow; scutellum and mediotergite yellow with a continuous dark median vitta. Pleura yellow. Halteres yellow, the bases of knobs black. Legs with the coxæ and trochanters yellow; femora brownish yellow, the tips narrowly blackened; tibiæ slightly darker than the femora, the tips very narrowly darkened; tarsi black. Wings (Plate 1, fig. 5) yellow, the prearcular and subcostal regions clear bright yellow; cell C more infumed; stigma dark brown; extreme apical margin darkened; remainder of disk variegated by pale brown clouds, including the wing tip; small darker brown areas in bases of cells R and M, at origin of Rs, and on anterior cord, the last extending across cell R_1 to isolate a small white spot before the stigma; veins brown, yellow in the flavous areas. Macrotrichia of veins relatively numerous; squama naked. Venation: Outer end of cell 1st M_2 strongly pointed by the obliquity of vein m; petiole of cell M_1 shorter than m.

Abdomen with basal tergites yellow, narrowly trilineate with dark brown, the lateral borders paler; sternites more uniformly pale; outer segments and hypopygium more uniformly blackened. Male hypopygium (Plate 2, fig. 30) with the tergite, 9*t*, fused on cephalic third with the sternite, 9*s*; basistyle (coxite), *b*, very large and powerful, entirely cut off from the sternite, produced caudad into a long arm that is a little expanded at distal end. Ninth tergite (Plate 2, fig. 31, 9*t*) completely divided along midline by pale membrane, the lateral lobes produced into short blackened horns, ventrad of each of which lies a slightly more extensive, darkened lobe. Dististyles as figured; beak of inner dististyle (Plate 2, fig. 31, *id*) heavily blackened, the outer posterior angle produced into a gently curved lobe; on face of style near base with a much longer rod. Ninth sternite, 9*s*, near caudal end on either side of midline with a conspicuous hair pencil of reddish bristles, these pencils not arising from basal tubercles. Ovipositor with the basal shield exceeding the cerci in length.

Habitat.—Formosa.

Holotype, male, Hassensan, altitude 6,532 feet, June 26, 1934 (*Gressitt*). Allotopotype, female, altitude 4,875 feet, June 22, 1934. Paratopotype, male, altitude 6,700 feet, June 26, 1934; paratype, female, Bukai, altitude 2,775 feet, June 14, 1934 (*Gressitt*).

Among the hitherto defined regional species, I regard the present fly as being most nearly allied to *Tipula terebrata* Edwards (Formosa), which differs in the black flagellum, distinct thoracic pattern, notably the blackened confluent inner margins of the intermediate præscutal stripes, and the truncated outer end of cell 1st M_2. Both of the above are allied to the species next described, *Tipula* (*Oreomyza*) *sternotuberculata* sp. nov. I would place all of these species in the subgenus *Oreomyza* Pokorny.

TIPULA (OREOMYZA) STERNOTUBERCULATA sp. nov. Plate 1, fig. 6; Plate 2, figs. 32 and 33.

Allied to *coxitalis;* antennæ of moderate length, bicolorous; præscutum olive-yellow, with four more olive-brown stripes; tips of femora broadly black; wings brown, variegated by darker brown and cream-colored areas; outer abdominal segments black; male hypopygium with the ninth sternite on either side of median line produced into long black tubercles that are tufted with relatively short golden yellow setæ; basistyle long-produced.

Male.—Length, 13 to 15 millimeters; wing, 15 to 18.

Frontal prolongation of head obscure yellow, a little darker above; nasus distinct; palpi brown. Antennæ (male) of moderate length, if bent backward extending about to root of halteres; scape, pedicel, and first flagellar segment yellow; succeeding flagellar segments bicolorous, the basal enlargements dark brown, the outer portions obscure yellow, on outer segments passing into brown; verticils shorter than the segments. Head olive-green, more yellowish in front; no distinct dark marking on vertex.

Pronotal scutellum pale with a conspicuous, dark brown, median spot. Mesonotal præscutum olive-yellow with four more olive-brown stripes, the intermediate pair separated by a pale line throughout the entire length; scutum pale olive-yellow, variegated by slightly darker olive-yellow; scutellum and mediotergite olive-green, with a capillary brown vitta that is scarcely evident. Pleura buffy, variegated by more olive-green on ane-

pisternum and sternopleurite. Halteres infumed, the base of stem and apex of knob yellow. Legs with the coxæ buffy; trochanters yellow; femora brownish yellow, the tips broadly black, with a more or less distinct, clearer yellow, subterminal ring; tibiæ dark brown; tarsi black. Wings (Plate 1, fig. 6) with the ground color brown, sparsely variegated by darker brown and with more abundant cream-colored areas; the darker spots include the stigma, together with an adjoining area on anterior cord and a mark at origin of Rs; bases of cells R and M not or scarcely darkened; veins brown. Venation: Rs long, just exceeding R_3; cell 1st M_2 small; petiole of cell M_1 a little longer than m.

Basal abdominal tergites yellow, indistinctly trivittate with brown, the lateral margins narrowly pale; at near midlength of the organ, the stripes become heavier; outer abdominal segments, including hypopygium, black; basal sternites more uniformly yellow. Male hypopygium (Plate 2, fig. 32) with the tergite, 9*t*, separated from the sternite, 9*s*, by membrane, united on cephalic portion. Basistyle, *b*, long-produced, as in *coxitalis*, but of different conformation. Ninth tergite (Plate 2, fig. 33, 9*t*) entirely divided medially; caudal lobes adjoining the mesal membrane clothed with long yellow setæ; ventrad of these lobes, a more-depressed blackened plate. Dististyles as figured; inner style (Plate 2, fig. 33, *id*). Ninth sternite, 9*s*, on either side of median line produced into long basal tubercles that are tufted with relatively short golden-yellow setæ.

Habitat.—Formosa.

Holotype, male, Arisan, altitude 7,640 feet, May 24, 1934 (*Gressitt*). Paratopotype, male, altitude 6,200 feet, May 26, 1934 (*Gressitt*).

The nearest ally of the present fly is undoubtedly *Tipula* (*Oreomyza*) *coxitalis* sp. nov., which differs most evidently in the hypopygial characters, notably the nontuberculate ninth sternite. Both species seem to be nearly allied to *T.* (*O.*) *terebrata* Edwards, the male of which is unknown.

TIPULA (OREOMYZA) RESUPINA sp. nov. Plate 1, fig. 7; Plate 2, fig. 34.

General coloration light gray, the præscutum with four dark grayish brown stripes, the intermediate pair darker in front and clearly divided by a capillary line of the ground color, becoming confluent behind; knobs of halteres infuscated; fore and middle femora black, the bases restrictedly yellow; posterior

femora yellow, the distal fourth black; tibiæ yellowish brown, the tips narrowly blackened; wings whitish subhyaline, the prearcular region and cell Sc light yellow; a sparse darker pattern on disk; R_{1+2} preserved on basal half; abdominal tergites narrowly lined medially with dark brown, the sternites more broadly so; male hypopygium with the tergite entirely pale; eighth sternite tufted with yellow setæ.

Male.—Length, about 11 millimeters; wing, 12.5.

Frontal prolongation of head brownish gray above, more sparsely pruinose on sides; nasus long and slender. Antennæ (male) of moderate length, if bent backward extending approximately to root of halteres; basal three segments clear light yellow; fourth segment yellow, with the base weakly darkened; succeeding segments bicolorous, dark basally, the remainder yellow, only the outer three or four segments more uniformly darkened; longest verticils a little shorter than the segments. Head clear ashy gray.

Mesonotal præscutum gray, with four dark grayish brown stripes, the intermediate pair darker in front and here clearly separated by a line of the ground color, converging behind and becoming confluent on posterior half; lateral stripes narrow and paling to the ground color behind; setigerous punctures of the interspaces relatively conspicuous; scutal lobes light gray, variegated by dark brownish gray areas; posterior sclerites of mesonotum light gray, the mediotergite with a linear median mark on cephalic half. Pleura light ashy gray; dorsopleural membrane pale yellow. Halteres pale yellow, the knobs infuscated. Legs with the coxæ light gray; trochanters brownish yellow; fore and middle femora black, only the bases restrictedly yellow; posterior femora obscure brownish yellow, with about the distal fourth black; tibiæ yellowish brown, the tips narrowly blackened; tarsi passing into black. Wings (Plate 1, fig. 7) with the ground color whitish subhyaline, sparsely variegated by pale brown; prearcular region and cell Sc light yellow; cell C slightly darker; stigma dark brown, confluent with a paler brown cloud on anterior cord; dark spot at origin of Rs small; outer ends of radial field darkened; longitudinal veins beyond cord, together with Cu_1 and 2d A, narrowly seamed with brown; veins brown, brighter in the flavous areas. Venation: R_{1+2} preserved on more than basal half, bent strongly backward or basad, widening the cell at margin; no macrotrichia on R_{1+2}; cell 1st M_2 relatively long and narrow.

Abdominal tergites obscure yellow, with a conspicuous dark brown median stripe that is narrowly interrupted at the posterior border of the segments; sternites chiefly dark brown, the lateral portions narrowly brightened. Male hypopygium (Plate 2, fig. 34) with the tergite, 9*t*, entirely separated from the sternite; basistyle entire. Ninth tergite (Plate 2, fig. 34, 9*t*) along the sides about as long as wide, narrower in the central portion, entirely pale in color; outer third narrowed, the caudal margin with a U-shaped notch; a tiny median incision, with short ridges on dorsal surface of tergite back from this point. Styli as shown, the outer dilated at outer end. Eighth sternite with an abundant brush of yellow setæ on caudal margin, those on the lateral portions longer and more conspicuous than those on median area.

Habitat.—China (Szechwan).

Holotype, male, Kwanhsien, altitude 2,000 to 4,000 feet, May 15 to 31, 1933 (*Graham*).

The wings of the present fly are most like those of *Tipula* (*Oreomyza*) *percara* Alexander (southwestern China, in September), the latter differing in the yellow halteres, barely indicated præscutal stripes, and median dark line on head. Other generally similar regional species, including *jedoensis* Alexander, *legalis* Alexander, *mutiloides* Alexander, *pedicellaris* Alexander, and *submutila* Alexander, differ in the blackened antennal flagellum and all details of venation and of body and wing coloration.

TIPULA (OREOMYZA) EXCETRA sp. nov. Plate 1, fig. 8.

Female.—Length, 15 to 16 millimeters; wing, 15 to 15.5.

Most nearly allied to *Tipula* (*Oreomyza*) *striatipennis* Brunetti (eastern Himalayas) and *T.* (*O.*) *quadrifasciata* Matsumura (Japan), differing in colorational details, as follows:

Compared with *striatipennis:* Antennæ with basal four segments yellow, the succeeding segments brownish black; in *striatipennis* the scape and pedicel are yellow, the basal flagellar segments bright reddish brown, only the outer segments becoming darker brown. Median præscutal stripe divided on posterior half by a dusky line, the anterior ends of the intermediate stripes darkened; setigerous punctures on interspaces conspicuous; in *striatipennis*, small and inconspicuous.

Compared with *quadrifasciata:* Frontal prolongation of head, including nasus, gray; in *quadrifasciata* the nasus is abruptly

light yellow. Antennæ with basal four segments yellow; in *quadrifasciata* the basal three, with the remaining segments are dark brown. In *quadrifasciata* the median præscutal stripe behind not divided by a dusky line; scutellum with a median brown vitta that is obsolete in *quadrifasciata.*

All three species agree in having a more or less distinct median line on the gray vertex; setigerous punctures on the præscutal interspaces; legs with all femora, excepting their very narrow bases, uniformly black; wings whitish, quadrifasciate with pale brown; cell C uniformly dark brown; vein R_{1+2} with all but a basal spur atrophied.

Habitat.—China (Szechwan).

Holotype, female, Kwanhsien, altitude 2,000 to 4,000 feet, May 15 to 31, 1933 (*Graham*). Paratopotype, female.

TIPULA (OREOMYZA) IGNOSCENS sp. nov.

Allied to *striatipennis;* mesonotal præscutum gray, with four brownish gray stripes, the intermediate pair confluent on posterior half; fore femora chiefly black, the middle and hind femora obscure yellow, with about the distal sixth blackened; wings cream-colored with four diffuse brown crossbands; prearcular region strongly suffused with yellow; cell C black; wing apex broadly darkened; vein R_{1+2} preserved as a basal spur.

Female.—Length, about 16 millimeters; wing, 15.5.

Frontal prolongation of head dark gray dorsally, the nasus concolorous; sides of prolongation brown; palpi black. Antennæ (female) relatively long, exceeding the palpi in length; flagellar segments much longer than in *excetra;* basal four segments yellow, the succeeding segments bicolorous, dark basally, the outer portion yellow; outer two or three segments more uniformly darkened; segments about as long as the longest verticils. Head gray, with a very delicate, barely indicated, capillary, dark line extending from the summit of the vertical tubercle to the occiput.

Mesonotum gray, the præscutum with four brownish gray stripes that are best indicated on their anterior ends, the intermediate pair confluent on posterior half, on anterior portion separated by a narrow gray line; setigerous punctures small; posterior sclerites of notum dark gray, the mediotergite with a central dark vitta. Pleura gray, the dorsopleural region more yellow. Halteres yellow, the knobs dark brown. Legs with the coxæ light gray; trochanters yellow; fore femora chiefly black,

the bases narrowly yellow; middle and hind femora obscure yellow, passing into brownish yellow, the tips narrowly blackened, involving only the distal sixth or approximately so; tibiæ and tarsi black. Wings much as in *excetra* but the ground color more creamy than white; posterior prearcular region strongly suffused with yellow; cell C uniformly black, much wider than in *excetra,* cell Sc correspondingly narrow; dark crossbands more extensive, encroaching on the ground color; second dark band widely expanded behind, in cell 1st A including the entire posterior border excepting a narrow space adjoining vein 1st A; wing tip more extensively darkened, restricting the poststigmal ground area, which here embraces only about one-third the length of cell R_3, in *excetra* and allies, nearly if not quite one-half the cell; veins yellow, brown in the clouded areas. Venation: R_{1+2} preserved as a basal spur that is nearly as long as R_2 alone; m-cu at the fork of M_{3+4}.

Abdominal tergites obscure yellow, with a broad, conspicuous, black, median stripe, most evident on the basal segments, becoming narrower and the surface more pruinose on the outer segments; sternites dark, the surface pruinose. Shield of ovipositor polished chestnut; cerci long and slender, straight.

Habitat.—China (Szechwan).

Holotype, female, Kwanhsien, altitude 2,000 to 4,000 feet, May 15 to 31, 1933 (*Graham*).

Tipula (*Oreomyza*) *ignoscens* is most closely allied to *T.* (*O.*) *striatipennis* Brunetti and allies, including the regional *excetra* sp. nov. and *latiflava* Alexander, differing especially in the pattern of the legs and wings.

TIPULA (LUNATIPULA) MULTISETOSA sp. nov. Plate 1, fig. 9; Plate 3, figs. 35 and 36.

Belongs to the *marmoratipennis* group; allied to *multibarbata;* antennal flagellum black; mesonotal præscutum light gray, with four brownish gray stripes that are narrowly bordered by dark brown; a continuous median brown vitta from the suture to base of abdomen; wings heavily marmorate with grayish brown, brown, and cream; m-cu uniting with M_{3+4} at near two-thirds the length; outer radial and medial cells of wing pale; male hypopygium with the lateral tergal lobes narrow, divergent; outer dististyle long, boomerang-shaped, with recurved black spines at tip.

Male.—Length, about 17 millimeters; wing, 19; antenna, about 5.

Frontal prolongation of head brownish yellow, darker laterally; nasus long and slender; palpi with basal three segments brown, the elongate terminal segment light yellow, its distal third darkened. Antennæ (male) moderately elongate, if bent backward extending about to root of halteres; scape and pedicel yellow, flagellum brownish black; longest verticils a little exceeding the segments. Front whitish; vertex buffy, with a conspicuous dark brown median stripe.

Mesonotal præscutum with the ground color light gray, with four brownish gray stripes that are narrowly margined with dark brown, the border not or scarcely involving the outer margin of the lateral stripes; additional brown lines on the humeral region and sublaterally before the suture; scutum gray, each lobe with two confluent brownish gray areas that are narrowly bordered by darker; posterior sclerites of mesonotum with a more golden yellow pollen; a continuous dark brown median line extending from the suture to the base of abdomen. Pleura heavily yellow pollinose. Halteres yellow, the knobs dark brown (distal ends broken in unique type). Legs with the coxæ grayish yellow; trochanters yellow; femora yellow basally, passing into brownish yellow, the tips black, preceded by a vague, yellow, subterminal ring; tibiæ and tarsi black. Wings (Plate 1, fig. 9) narrow, with long basal petiole; ground color grayish brown, heavily marmorate with cream-yellow and darker brown areas; cell Sc uniformly blackened, cell C pale yellow; a narrow darkening in bases of cells R and M; conspicuous dark clouds on anterior cord, outer end of cell 1st M_2, at midlength of outer radial field, and across cells R, M, Cu, and the anals; outer radial and medial cells chiefly pale, with restricted dark marginal clouds at ends of longitudinal veins; veins dark brown. Squama with setæ; very sparse trichia on vein R_3; a series of about a score of trichia on basal fifth of vein 1st A. Venation: R_{1+2} entire; R_3 rather strongly arcuate, slightly narrowing cell R_3; m-cu at two-thirds the length of M_{3+4}.

Basal abdominal tergites brownish yellow, the basal segments blackened sublaterally; fifth and succeeding segments uniformly blackened, the eighth sternite somewhat paler. Male hypopygium (Plate 3, fig. 35) relatively small, the ninth segment considerably reduced; tergite, 9*t*, incompletely separated from the small sternite, 9*s*, by a posterior incision; basistyle very small. Ninth tergite (Plate 3, fig. 36, 9*t*) narrowly transverse, the caudal margin laterally produced into two slender black lobes

that are divergent and strongly upturned, the margin weakly serrulate; a low rounded lobe in the middle of the sclerite, placed farther cephalad than the lateral lobes, this cushion densely set with small black spines; behind these three lobes the narrow dorsal portion of the tergite bears long, dense, brown setæ distributed over almost the whole segment, the band of punctures narrowest on the midline. Outer dististyle (Plate 3, fig. 35, *od*) a long, gently arcuated, dark-colored rod, the apex blackened, the general shape about like a boomerang; apex of style with several recurved black spines. Inner dististyle (Plate 3, fig. 35, *id*) shorter, with heavily blackened spines at apex and at near midlength. Eighth sternite (Plate 3, fig. 36, 8*s*) large, sheathing the ninth; each lateral angle produced into a rounded knob that bears about a dozen long setæ, which are more or less decussate across the midline of body; caudal border of sternite, between the lobes, nearly straight, with a dense flat group of yellow setæ on either side of the midline.

Habitat.—China (Szechwan).

Holotype, male, Kwanhsien, altitude 2,000 to 4,000 feet, May 15 to 31, 1933 (*Graham*).

The nearest ally of the present fly is *Tipula* (*Lunatipula*) *multibarbata* Alexander (Korea), which differs conspicuously in the wing pattern, venation, and details of the male hypopygium.

TIPULA (SCHUMMELIA) STRICTIVA sp. nov. Plate 1, fig. 10.

General coloration of mesonotum light brown, the præscutal stripes very indistinct; hind femora chiefly black, with approximately the basal third yellow; fore femora more uniformly brown; tibiæ and tarsi black; wings strongly tinged with yellow; stigma dark brown; m-cu narrowly seamed with brown; abdominal tergites yellow, the posterior and lateral margins narrowly brown.

Female.—Length, about 11 millimeters; wing, 11.8.

Frontal prolongation of head relatively short, yellowish brown; palpi dark brown. Antennæ (female) with the basal three segments yellow; succeeding flagellar segments bicolorous, yellow, with the basal enlargements conspicuously black; outer flagellar segments more uniformly infumed; longest verticils unilaterally distributed, in female exceeding the segments in length. Front whitish pruinose; posterior portion of head brown.

Mesonotum light brown, the præscutal stripes very indistinct, the intermediate pair vaguely bordered by narrow darker

lines, a capillary median vitta being somewhat more evident; mediotergite sparsely pruinose. Pleura yellow. Halteres yellowish brown. Legs with the coxæ and trochanters pale yellow; femora chiefly black, the basal third or thereabouts paler; fore femora more uniformly brown; tibiæ and tarsi black. Wings (Plate 1, fig. 10) with a strong yellow tinge, the prearcular field and cell Sc more intense, clearer yellow; cell C, anterior portion of cell R and outer radial field more infumed; stigma long-oval, dark brown, preceded and followed by restricted clear yellow areas; outer medial veins, m-cu, and distal section of Cu_1 narrowly seamed with brown; veins yellow, darker in the clouded portions of the medial field. No macrotrichia in cells of wing. Venation: R_{1+2} entire but pale, with trichia at proximal end only; R_2 subequal to R_1; cell 1st M_2 small.

Abdominal tergites yellow, the posterior and lateral margins narrowly brown; sternites more uniformly light yellow. Cerci straight and very slender.

Habitat.—Formosa.

Holotype, female, Taiheizan, altitude 5,500 feet, July 8, 1934 (*Gressitt*).

Tipula (*Schummelia*) *strictiva* is most nearly alied to *T.* (*S.*) *rantaicola* Alexander, likewise of Formosa, differing in the chiefly blackened femora and the strongly yellow wings.

TIPULA SINDENSIS sp. nov. Plate 1, fig. 11; Plate 3, fig. 37.

Belongs to the *thibetana* group; allied to *griseipennis;* size small (wing, 13.5 to 14 millimeters); antennal flagellum dark brown; mesonotal præscutum light gray, with three darker gray stripes, the median one narrowly and conspicuously bordered by darker brown; femora brownish yellow, the tips narrowly blackened; wings pale grayish brown, tesselated with slightly darker brown and cream-colored areas; cell 1st M_2 long; abdominal tergites orange-yellow, with a conspicuous dark brown stripe on either side.

Male.—Length, about 13 to 13.5 millimeters; wing, 13.5 to 14.

Frontal prolongation of head relatively elongate, dark gray; nasus very small; palpi black. Antennæ with scape brownish yellow; pedicel a little clearer yellow; flagellar segments uniformly dark brown; verticils shorter than the segments. Head brownish gray.

Pronotum gray, variegated with brown medially and on the sides. Mesonotal præscutum light gray, with three darker gray

stripes, the median one narrow and conspicuously bordered for its whole length by dark brown, and very faintly and inconspicuously split medially by a dusky vitta; lateral stripes with a dark spot at cephalic end; scutal lobes light gray, variegated by dark areas; posterior sclerites of mesonotum gray. Pleura gray, the dorsopleural membrane more dusky. Halteres pale, the base of stem restrictedly pale, the knobs infuscated. Legs with the coxæ gray; trochanters obscure yellow, weakly pruinose; femora brownish yellow, the tips narrowly blackened; tibiæ yellowish brown, the tips passing into black; tarsi black, the proximal ends of basitarsi paler. Wings (Plate 1, fig. 11) pale grayish brown, tesselated with slightly darker brown and cream-yellow areas, the pattern arranged much as in *griseipennis;* veins dark brown. Venation: R_3 variable in its course, in the type rather strongly upcurved at outer end, in paratype more nearly straight; posterior medial and cubital veins bent basad at margin; cell 1st M_2 long, cell M_1 relatively short.

Abdomen with basal tergite dark brownish gray, restrictedly variegated by pale; succeeding tergites orange-yellow, with broad, conspicuous, sublateral, brown stripes that are slightly interrupted at the posterior borders; extreme lateral margins of tergites grayish pruinose; sternites orange-yellow, darker laterally; subterminal segments brownish black, the styli yellow. Male hypopygium with the styli of peculiar conformation, as shown by the figure (Plate 3, fig. 37, *id, od*).

Habitat.—Kashmir.

Holotype, male, Sind Valley, altitude 7,000 feet, June 11, 1934 (*Miss Hutchinson*). Paratopotype, male.

The nearest ally of the present fly seems to be the larger *Tipula griseipennis* Brunetti, which is from the Garhwal District of India. In addition to the major size, the latter species differs especially in the bicolorous antennæ, the different pattern of the præscutum and abdomen, and the structure of the male hypopygium.

Genus DOLICHOPEZA Curtis

Dolichopeza CURTIS, British Entomology (1825) 62.

Subgenus SINOROPEZA subgenus novum

Characters as in *Oropeza* Needham, differing especially in the venation of the medial field of the wing. Wing (Plate 1, fig. 12) with Sc relatively long, Sc_2 ending just before fork of Rs; tip of R_{1+2} entirely atrophied, R_2 meeting R_1 at a strong angle;

Rs straight, oblique, a little longer than the basal section of R_{4+5}; cell 1st M_2 open by atrophy of basal section of vein M_3; cell 2d M_2 petiolate; cell 1st M_2 confluent with cell M_3; second section of vein M_{1+2} subequal to basal section of M_2; m-cu more than its own length before departure of vein M_{3+4}. Subgenotype with numerous strong macrotrichia in cells Sc_2 to M_3, inclusive, these lacking in *postica*.

Type of subgenus.—*Dolichopeza* (*Sinoropeza*) *pluricoma* sp. nov. (Eastern Palæarctic Region: Western China.)

I am referring here also *Dolichopeza postica* Brunetti (eastern Himalayas), which has an almost identical venation but lacks the macrotrichia in the cells of the wing. The venation is quite unique in the entire family Tipulidæ in that cell 2d M_2 is long-petiolate by the presence of a basal section of vein M_2, producing the appearance of a posterior fork in the outer medial field.

DOLICHOPEZA (SINOROPEZA) PLURICOMA sp. nov. Plate 1, fig. 12.

General coloration of thoracic notum dark brown, the præscutum with three more reddish brown stripes; wings strongly tinged with dusky, the stigma darker; macrotrichia in outer ends of cells Sc_2 to M_3, inclusive.

Female.—Length, about 8 millimeters; wing, 10.

Rostrum and palpi dark brown. Antennæ dark brown throughout; basal flagellar segment (female) very long, approximately equal in length to the succeeding two and one-half segments; verticils much shorter than the segments. Head dark brown.

Mesonotum dark brown, the præscutum with three slightly brighter, more reddish brown stripes; posterior sclerites of mesonotum and the pleura rather uniformly dark brown. Halteres dusky, the extreme base of stem brightened. Legs with the coxæ dark brown; trochanters obscure yellow; femora obscure yellow basally, the tips passing into brownish black; tibiæ and basitarsi brown, the tips brownish black; outer tarsal segments black. Wings (Plate 1, fig. 12) with a strong dusky tinge; stigma oval, dark brown; a restricted brown cloud on anterior cord; veins R_{4+5}, Cu_1, and 2d A narrowly seamed with brown; pale areas before and beyond the stigma poorly defined; veins and macrotrichia dark brown. Macrotrichia in outer radial and medial cells of wing (shown in figure by stippled dots), beginning as single lines in the more basal portions of the cells, becoming more numerous and crowded in the outer portions. Venation as

discussed under the characterization of the subgenus; cell 2d A relatively wide.

Abdomen brown, the incisures somewhat darker. Ovipositor with all but the extreme bases of valves broken, but from what remains apparently of somewhat peculiar structure.

Habitat.—China (Szechwan).

Holotype, female, Beh Luh Din, 30 miles north of Chengtu, altitude 6,000 feet, August 25, 1933 (*Graham*).

The species needs comparison only with *Dolichopeza* (*Sinoropeza*) *postica* Brunetti, which is readily told by the glabrous cells of the wing.

CYLINDROTOMINÆ

CYLINDROTOMA AURANTIA sp. nov. Plate 1, fig. 13.

Entire thorax fiery orange; legs black, the extreme bases of femora obscure yellow; wings strongly suffused with black, cells C and Sc a little darker; abdomen with basal tergite yellow, the remainder of abdomen black.

Female.—Length, about 10 to 10.5 millimeters; wing, 9.5 to 10.

Rostrum and palpi black. Antennæ black throughout. Head black, the anterior vertex and posterior orbits obscure yellow; anterior vertex unusually wide.

Entire thorax, including notum and pleura, fiery orange, unmarked. Halteres black, the base of stem restrictedly yellow. Legs with the coxæ and trochanters orange; femora black, the extreme bases obscure yellow; remainder of legs black. Wings (Plate 1, fig. 13) strongly suffused with black, cells C and Sc a little darker; stigma relatively small, still deeper black; no further darkenings at origin of Rs or along cord; veins black. Venation: m-cu more than its length beyond fork of M; petiole of cell M_1 short, much less than m.

Abdomen with basal tergite yellow; remainder of abdomen, including the genital segments, black, the outer segments weakly pruinose.

Habitat.—China (Szechwan).

Holotype, female, Beh Luh Din, 30 miles north of Chengtu, altitude 6,000 feet, August 24, 1933 (*Graham*). Paratype (sex?), Wei Chow, 65 miles northwest of Chengtu, altitude 9,000 to 12,500 feet, August 15, 1933 (*Graham*).

Cylindrotoma aurantia is most nearly allied to *C. rufescens* Edwards (Tibet), differing very conspicuously in the entirely orange thorax and, beyond the basal segment, the entirely black

abdomen. The black legs are much as in the otherwise distinct *C. nigripes* Alexander (Szechwan-Tibet border). It should be noted that the wings of the type appear to be stained or discolored with a bluish or purplish tinge that does not show in the broken paratype and is undoubtedly abnormal for the species.

LIMONIINÆ

LIMONIINI

LIMONIA (LIBNOTES) IMMETATA sp. nov. Plate 1, fig. 14; Plate 3, fig. 38.

Allied to *familiaris;* antennæ black, the flagellar segments with unusually long verticils; head plumbeous gray; eyes virtually continguous on vertex; mesothorax uniformly light orange-yellow, the mesonotum unmarked; knobs of halteres infuscated; wings whitish, the prearcular and costal regions yellow; a restricted brown pattern; Sc_1 long; male hypopygium with the tergal lobes bearing long setæ.

Male.—Length, about 8.5 millimeters; wing, 9.5.

Rostrum brownish yellow; palpi black. Antennæ black throughout, the scape a little pruinose; flagellar segments long-oval to subcylindrical, the longest verticils of unusual length, between three and four times as long as the segments; terminal segment elongate, narrowed at tip, approximately one-half longer than the penultimate. Head dark plumbeous gray; anterior vertex reduced to a mere strip or with the eyes actually contiguous.

Pronotum brown. Mesonotum uniformly light orange-yellow, unmarked, the pleura a little more yellowish. Halteres pale, the knobs infuscated. Legs with the coxæ and trochanters pale yellow; femora yellow, the tips weakly darkened; tibiæ and tarsi obscure yellow, the outer tarsal segments dark brown. Wings (Plate 1, fig. 14) whitish, the prearcular region and cells C and Sc clearer yellow; a sparse brown pattern, including the stigma; a large area at origin of Rs and smaller marks at arculus; wing tip in outer radial field vaguely darkened; a very restricted dark seam on cord, more evident at the fork of Rs; narrow clouds along vein Cu and as a marginal seam to just beyond vein Cu_1; veins dark brown, brighter in the flavous areas. Venation: Sc long, Sc_1 ending beyond r-m, Sc_2 some distance from its tip, just beyond fork of Rs, Sc_1 exceeding one-half the length of Rs; outer radial veins strongly decurved towards outer ends; cell 1st M_2 relatively small; m-cu not far beyond fork of M, subequal to the distal section of Cu_1; anal veins gently divergent.

Abdominal tergites dark brown, narrowly paler on lateral borders; sternites brownish yellow; hypopygium yellow. Male hypopygium (Plate 3, fig. 38) with the tergite, 9*t*, long, the caudal margin with a broad U-shaped notch, the lateral lobes with long conspicuous setæ that are virtually lacking elsewhere on tergite. Ventral dististyle, *vd*, fleshy, the rostral prolongation blackened, with two spines of very unequal size, the inner one a mere seta. Gonapophyses, *g*, with mesal-apical lobe slender, blackened, the inner or concave margin with microscopic spines.

Habitat.—Formosa.

Holotype, male, Rokki, altitude 1,000 feet, May 17, 1934 (*Gressitt*).

The present species is allied to *Limonia* (*Libnotes*) *clitelligera* (Alexander), likewise of Formosa, differing especially in the coloration of the thorax. By Edwards's key to the species of *Libnotes* [2] the fly runs to couplet 57, disagreeing with all species beyond this point in the immaculate mesonotum.

LIMONIA (LIMONIA) TUTA sp. nov. Plate 1, fig. 15.

General coloration of mesonotum brown medially, paling to yellow on sides; knobs of halteres darkened; legs brownish yellow, the outer tarsal segments darkened; wings with a faint brown tinge, the short-oval stigma darker brown; cell 1st M_2 open by the atrophy of basal section of vein M_3; abdominal tergites dark brown; cerci slender, gently upcurved to the acute tips.

Female.—Length, about 5 millimeters; wing, 5.

Rostrum and palpi pale brown, greatly reduced. Antennæ with scape and pedicel black; flagellum broken. Head dark gray; eyes contiguous on anterior vertex.

Pronotum brownish black. Mesonotal præscutum brown medially, obscure yellow on sides, the extreme lateral border of sclerite darkened before the suture; scutal lobes dark brown, the median area pale; scutellum and mediotergite yellowish brown. Pleura yellow, with a conspicuous, dark brown, longitudinal stripe extending from the propleura across the anepisternum, pteropleurite, and pleurotergite to the base of abdomen; dorsopleural membrane obscure yellow; sternopleurite clearer yellow. Halteres pale, the knobs darkened. Legs with the coxæ

[2] Journ. Fed. Malay St. Mus. 14 (1928) 74–80.

pale yellow, the fore coxæ a trifle more darkened; trochanters yellow; remainder of legs pale brownish yellow, the outer tarsal segments brown. Wings (Plate 1, fig. 15) with a faint brown tinge, the short-oval stigma darker brown; veins brown. Macrotrichia of veins beyond origin of Rs relatively long and conspicuous; a restricted series of trichia at outer ends of both anal veins. Venation: Sc_1 ending shortly beyond midlength of Rs, Sc_2 a short distance from its tip; free tip of Sc_2 and R_2 in transverse alignment; cell 1st M_2 open by the atrophy of basal section of vein M_3; m-cu close to fork of M, considerably exceeding the distal section of Cu_1; anal veins at origin nearly parallel.

Abdominal tergites dark brown, the sternites somewhat paler. Cerci slender, gently upcurved to the acute tips, exceeding the hypovalvæ in length.

Habitat.—Formosa.

Holotype, female, Hassensan, altitude 4,900 feet, June 27, 1934 (*Gressitt*).

Limonia (*Limonia*) *tuta* is very different from other regional species in having cell 1st M_2 of the wings open by the atrophy of the basal section of vein M_3. This is a very uncommon feature in the entire genus. The Philippine *L.* (*L.*) *bagobo* Alexander, which has a somewhat similar venation, is in all other regards a very different fly.

LIMONIA (RHIPIDIA) SYNSPILOTA sp. nov. Plate 1, fig. 16; Plate 3, fig. 39.

Belongs to the *maculata* group; general coloration gray, the præscutum with a brown median stripe; antennæ (male) with nine bipectinate flagellar segments; wings whitish, with an abundant gray dotting in cells; a heavier costal pattern, the area at tip of Sc and origin of Rs common; Sc relatively short; male hypopygium with the rostral prolongation of the ventral dististyle with two long slender spines close to extreme tip.

Male.—Length, about 7 millimeters; wing, 8.

Female.—Length, 7.5 to 8 millimeters; wing, 8.5 to 9.

Rostrum and palpi dark brown. Antennæ (male) black, the apical pedicels of flagellar segments whitish; flagellar segments two to ten, inclusive, bipectinate, the longest branches more than twice the segments; branches of flagellar segment two a little exceeding the segments; branches of flagellar segment ten relatively short, somewhat unequal in length; flagellar segment eleven with a single branch that is about as long as the segment;

terminal segment simple; in female, flagellar segments long-oval. Head dark gray.

Mesonotal præscutum gray, with a brownish median stripe that does not quite reach the suture; remainder of notum gray, the scutal lobes variegated with darker. Pleura dark gray. Halteres pale yellow. Legs with the coxæ brownish gray, paler at tips; trochanters yellow; femora yellow, the tips conspicuously dark brown; tibiæ and basitarsi yellow, the tips narrowly and weakly darkened; outer tarsal segments passing into black. Wings (Plate 1, fig. 16) whitish, all cells with numerous pale gray clouds; a series of four larger and darker costal areas, the third a common one over the tip of Sc and origin of Rs; cord and outer end of cell 1st M_2 seamed with grayish brown; a large rounded spot at outer end of vein 2d A; veins pale, darker in the clouded areas. Venation: Sc short, Sc_1 ending about opposite one-fourth to one-fifth the length of Rs, Sc_2 near its tip; a supernumerary crossvein in cell Sc; m-cu some distance before the fork of M.

Abdomen dark brown, the sternites in male slightly paler. Male hypopygium (Plate 3, fig. 39) with the tergite, *9t*, transverse, narrowed posteriorly, its caudal margin very gently emarginate. Basistyle, *b*, with a single simple ventromesal lobe. Ventral dististyle, *vd*, fleshy, the rostral prolongation with two long slender spines placed almost at extreme tip, these spines subequal in length to the prolongation itself, the outer spine a trifle longer than the inner. Gonapophyses, *g*, with the mesal-apical lobe simple, the tip blackened, acute.

Habitat.—Kashmir.

Holotype, male, Kaj-Nag Range, altitude 8,000 feet, May 26, 1934 (*Miss Hutchinson*). Allotopotype, female, pinned with type. Paratopotypes, 1 female, pinned with type; 1 female, May 22, 1934; 1 female, altitude 9,000 feet, June 3, 1934.

The present fly is closest to *Limonia* (*Rhipidia*) *subtesselata* (Brunetti) and *L.* (*R.*) *antennata* (Brunetti), being readily told by the nature of the pectinations of the antennæ and the bispinous rostral prolongation of the male hypopygium. Both Brunetti's description and Bagchi's figure of the antenna of *antennata* indicate that all twelve of the flagellar segments are bipectinate, a condition that if true is unique in the genus. Edwards's

rediscussion of the type[3] makes no mention of the antennal characters but merely compares the fly with *subtesselata.*

DICRANOPTYCHA VULPES sp. nov. Plate 1, fig. 17.

General coloration of thorax light yellowish brown, without markings; antennal scape and pedicel yellow, flagellum black; legs yellow, the outer tarsal segments brownish black; wings uniformly suffused with bright fulvous; Rs subequal in length to cell 1st M_2.

Female.—Length, 9 to 10 millimeters; wing, 9.5 to 10.5.

Rostrum brown; palpi dark brown. Antennæ with scape and pedicel yellow, flagellum black; segments subcylindrical, with verticils that exceed the segments in length. Head brown, sparsely yellow pollinose.

Mesonotum and pleura uniformly light yellowish brown, without markings. Halteres pale throughout. Legs with the coxæ and trochanters yellow; femora yellow, a little brighter on basal portion; tibiæ and basitarsi yellow, the tips of latter and succeeding segments brownish black. Wings (Plate 1, fig. 17) uniformly suffused with bright fulvous, the veins slightly more brownish yellow. Venation: Rs subequal in length to cell 1st M_2; m-cu a little less than its length beyond fork of M.

Abdominal tergites obscure yellow medially, bordered laterally with brown; sternites yellow, more or less darkened medially.

Habitat.—China (Szechwan).

Holotype, female, Beh Luh Din, 30 miles north of Chengtu, altitude 6,000 feet, August 18 and 19, 1933 (*Graham*). Paratopotypes, 2 females, August 18 to 25, 1933.

Dicranoptycha vulpes is very different from all other regional described species in the bright fulvous color of the wings, which is almost exactly like that of the larger Eastern Nearctic *D. germana* Osten Sacken, type of the genus. The genus *Dicranoptycha* is new to the fauna of China.

PEDICIINI

NIPPONOMYIA SZECHWANENSIS sp. nov. Plate 1, fig. 18; Plate 3, fig. 40.

Mesonotum reddish brown, unmarked; legs yellow; wings with a faint brownish yellow tinge, with the usual yellow, brown-margined costal pattern; no black costal dashes; cell 1st M_2 closed; m transverse; male hypopygium with the dististyle having only three or four spines.

[3] Rec. Indian Mus. 26 (1924) 297.

Male.—Length, about 11 millimeters; wing, 12.

Rostrum and palpi brownish black. Antennæ brownish yellow, with only the outer flagellar segments slightly darker. Head brownish yellow, the vertex sparsely pruinose.

Mesonotum reddish brown, the surface subnitidous; præscutum without black markings as is the case in all other regional members of the genus; central portion of præscutum, on anterior half, a little infumed. Pleura yellow. Halteres yellow throughout. Legs yellow, the terminal two tarsal segments dark brown. Wings (Plate 1, fig. 18) with a faint brownish yellow tinge, with the usual yellow, brown-margined costal pattern of the genus; costal cell without black transverse lines; outer radial field darkened; very narrow brown seams at origin of Rs, along cord, at fork of Rs, and on crossvein m; veins dark brown. Venation: r-m about its own length before the fork of Rs, the latter branching almost simultaneously into three; R_{2+3} perpendicular at origin, lying most closely to R_1 at bend and again at fork; cell R_4 widest just beyond midlength; m present, transverse.

Abdominal segments bicolorous, the basal ring darker just beyond its proximal end, the outer end and incisures pale. Male hypopygium (Plate 3, fig. 40) with the dististyle, *d*, terminating in only three or four spines.

Habitat.—China (Szechwan).

Holotype, male, Kwanhsien, altitude 2,000 to 4,000 feet, May 15 to 31, 1933 (*Graham*).

The genus *Nipponomyia* had not before been recorded from China. *Nipponomyia szechwanensis* is very different from the other known species. The unmarked mesonotum is much like that found in *flavicollis*, but in all other respects the two flies are entirely different. The known species of the genus may be separated by means of the accompanying key.

Key to the species of Nipponomyia Alexander.

1. Thoracic dorsum without black spots on mesonotal præscutum and scutum ..... 2.
   Thoracic dorsum with polished black spots on præscutum and scutum.. 3.
2. Tips of femora and tibiæ narrowly darkened; wings with the yellow costal pattern pale, interrupted by four or five large brown areas. (North Borneo.) ..... *flavicollis* Edwards.
   Femora and tibiæ uniformly yellow; wings with yellow costal pattern deep and conspicuous, interrupted only by small, inconspicuous spots. (Western China.) ..... *szechwanensis* sp. nov.

3. A series of black transverse dashes in costal cell of wing..... 4.
   Costal cell of wing without black dashes..... 6.
4. Wings with cell 1st M_2 open by atrophy of m; dististyle of male hypopygium with about twelve black spines. (Japan.)
   kuwanai (Alexander).
   Wings with cell 1st M_2 normally closed; dististyle of male hypopygium with only two or three black spines..... 5.
5. Legs yellow; wings with m transverse. (Formosa.)
   symphyletes (Alexander.)
   Legs with tips of femora and tibiæ blackened, wings with m present or lacking; when present, very oblique in position, ending almost at tip of vein M_3. (Northern India.).... *novem-punctata* (Senior-White).
6. Legs yellow; a series of about nine small black spots on mesonotal præscutum and scutum; wings without large dark clouds at Sc_2, origin of Rs, and tip of vein 2d A; m very oblique, its outer end lying far out on vein M_3. (Japan.)..... *trispinosa* (Alexander).
   Legs with femora tipped with brown; mesonotal præscutum with two large black areas at posterior end; scutum almost uniformly black; wings with large dark clouds at Sc_2, origin of Rs, and tip of vein 2d A; m slightly oblique, shorter than the distal section of vein M_3. (Sumatra.) ..... *sumatrana* (de Meijere).

ULA COMES sp. nov. Plate 1, fig. 19.

Mesonotum brownish black, sparsely pruinose; antennæ elongate, flagellum black; pleura and pleurotergite variegated black and yellow; wings yellow, heavily patterned with brown; cell 1st M_2 unusually large, subequal in length to vein M_4; abdominal tergites, including the genital shield, black.

Female.—Length, about 7 millimeters; wing, 8.

Rostrum brown; palpi brownish black. Antennæ elongate; scape and pedicel yellow, flagellum black; flagellar segments cylindrical, the longest verticils a little exceeding the segments. Head gray.

Mesonotal præscutum brownish black, sparsely pruinose; scutum and scutellum more pruinose; mediotergite brownish gray. Pleura with the anepisternum and sternopleurite brownish gray, the pteropleurite and pleurotergite yellow, the latter lined with black on the more ventral portions adjoining the root of halteres. Halteres yellow, the knobs dark brown. Legs with the coxæ yellow; trochanters yellow; femora brownish yellow, the tips narrowly dark brown; tibiæ brownish yellow, the tips narrowly brownish black; tarsi black. Wings (Plate 1, fig. 19) yellow, the stigmal area clearer yellow; an unusually heavy brown pattern, including spots at origin of Rs, Sc_2 and R_2 and seams along cord and outer end of cell 1st M_2; restricted dusky clouds at ends of outer radial veins; wing apex very narrowly bordered

with brown; narrow dusky washes along vein M and along both anal veins, that at 2d A not quite touching the vein; dark seam at cord entirely crossing wing from Sc_1 to Cu_1; veins brown, somewhat darker in the clouded areas. Macrotrichia of cells abundant (in figure, represented by stippled dots). Venation: r-m connecting with Rs at its fork, in alignment with R_5; cell 1st M_2 unusually long, subequal to vein M_4; m-cu shortly beyond fork of M.

Abdominal tergites black; sternites obscure brown, the outer segments blackened; genital shield chiefly black; cerci strongly upcurved, compressed, brownish black; hypovalvæ white.

Habitat.—China (Szechwan).

Holotype, female, Wei Chow, 65 miles northwest of Chengtu, altitude 9,000 to 12,500 feet, August 15, 1933 (*Graham*).

Ula comes is most generally similar to *U. superelegans* Alexander (Formosa), which has a somewhat similar heavy wing pattern but with the details distinct, and with cell 1st M_2 much smaller, in length not exceeding two-thirds vein M_4. The genus is new to the Chinese Republic.

HEXATOMINI

EPIPHRAGMA (EPIPHRAGMA) BICINCTIFERA sp. nov. Plate 1, fig. 20; Plate 3, fig. 41.

Mesonotal præscutum dark brown, with four reddish brown stripes on the anterior part of sclerite; antennæ relatively long; femora yellow, each with two conspicuous black rings, remainder of legs yellow; wings whitish, with a buffy brown pattern that is bordered by darker brown; m-cu a little more than one-half its length beyond the fork of M; male hypopygium with the interbase long and filiform.

Male.—Length, about 11 to 12 millimeters; wing, 11 to 12.

Female.—Length, about 10 millimeters; wing, 11.

Rostrum brown above, paler laterally; palpi black. Antennæ with the scape dark brown; pedicel a little paler; first flagellar segment yellow, succeeding segments dark brown, with long conspicuous verticils that exceed the segments. Head deep brown, the front and posterior orbits obscure yellow, the latter with a silvery pruinosity.

Mesonotal præscutum dark brown, with four reddish brown stripes in front and at midlength of the segment; posterior third or more of sclerite more uniformly dark brown; posterior margins of præscutum, behind the pseudosutural foveæ, darker brown; scutal lobes chiefly dark brown; scutellum dark brown;

mediotergite dark brown laterally and on posterior portion, the anterocentral portion gray pruinose. Pleura obscure brownish yellow, narrowly lined longitudinally with brown, including a more-dorsal stripe from the propleura to the base of halteres, and a more-ventral area including the ventral sternopleurite and meron. Halteres obscure yellow, the base of stem and apex of knob pale. Legs with the coxæ and trochanters pale; femora yellow, each with two conspicuous black rings, the first immediately distad of midlength, the second subapical, a trifle wider than the yellow apex; tibiæ and tarsi yellow, only the last tarsal segment darkened. Wings (Plate 1, fig. 20) whitish, with a handsome buffy brown pattern that is bordered by darker brown, the areas in the cubital and anal cells more solidly brown; seam on supernumerary crossvein in cell C isolated from other dark markings; the pattern is much as in *ornatipennis* (Brunetti), as figured by Brunetti,[4] but the dark areas beyond cord more broken. Venation: r-m variable in length, from very short (as shown) to normal; m-cu a little more than one-half its length beyond fork of M.

Abdominal tergites dark brown, the caudal borders narrowly yellow; sternites yellow, a little infumed at the incisures; hypopygium brownish black. Male hypopygium (Plate 3, fig. 41) with the outer dististyle, *od*, relatively long and slender. Interbase, *i*, a long, slender, filiform rod, the surface smooth, without transverse or oblique grooves on surface near tip, as is the case in *subinsignis* and allies.

Habitat.—China (Szechwan).

Holotype, male, Beh Luh Din, 30 miles north of Chengtu, altitude 6,000 feet, August 27, 1933 (*Graham*). Allotopotype, female, September 1, 1933. Paratopotype, male, August 18, 1933.

Epiphragma (*Epiphragma*) *bicinctifera* is very different from other regional species of the genus in the conspicuously biannulate femora. It is most generally similar to species such as *E.* (*E.*) *subinsignis* Alexander, but amply distinct in the coloration and details of structure of the male hypopygium. The genus *Epiphragma* had not been recorded from China.

Genus GRAHAMOMYIA novum

Palpi 4-segmented. Antennæ 16-segmented, all segments distinct; outer flagellar segments gradually smaller, the last longer

[4] Rec. Indian Mus. 15 (1918) pl. 7, fig. 5, as *Limnophila*.

than the penultimate. Anterior vertex relatively wide, approximately twice the diameter of the scape. Tuberculate pits and pseudosutural foveæ lacking. Tibial spurs small but distinct. Wings (Plate 1, fig. 21) with Sc long, Sc_1 ending some distance beyond fork of Rs, Sc_2 not far removed from its tip; R_2 lacking; petiole of cell R_3 subequal in length to the cell; a supernumerary crossvein at about its own length beyond origin of vein R_4, connecting this vein with vein R_5, forming a closed cell 1st R_4 that is very similar in size and outline to cell 1st M_2; basal section of R_5 more or less reduced; Rs long, square and long-spurred at origin; cell M_1 lacking; m-cu at or before midlength of M_{3+4}; anterior arcullus broken. Male hypopygium (Plate 3, fig. 42) massive, cylindrical, the tergite, 9*t*, and sternite, 9*s*, fused, the basistyle, *b*, incompletely separated from the sternite by a suture, the general structure of the hypopygium not unlike that of the tipuline crane flies. Ovipositor with the cerci and hypovalvæ subequal in length and of approximately similar form, the margins of both valves entire.

Genotype.—Grahamomyia bicellula sp. nov. (Palæarctic Region: Western China.)

I take very great pleasure in dedicating this new group of crane flies to the collector of the type species, the Rev. Mr. David C. Graham, who has added very materially to our knowledge of the tipulid fauna of western China. The nearest ally is undoubtedly *Phyllolabis* Osten Sacken, which differs especially in the venation and different structure of the male hypopygium. The presence of a supernumerary crossvein in cell R_4, connecting veins R_4 and R_5 to form a second closed or discal cell, 1st R_4, is quite unique in the entire family Tipulidæ. It is approached only by *Cyttaromyia* Scudder, a cylindrotomine genus, which has a supernumerary crossvein in cell R_5, connecting posteriorly with vein M_1 to form a second discal cell, 1st R_5, immediately cephalad of and in contact with the normal cell, 1st M_2. The location of the supernumerary crossvein in cell R_4, forming cells 1st R_4 and 2d R_4, is quite as in the lower brachycerous dipteron families where this condition occurs (certain Asilidæ, Nemestrinidæ, and Bombyliidæ), as discussed in another paper.[5]

[5] Alexander, C. P., A comparison of the systems of nomenclature that have been applied to the radial field of the wing in the Diptera, Proc. IV. Internat. Congress Ent. for 1928 2 (1929) 700–707, 3 pls.

GRAHAMOMYIA BICELLULA sp. nov. Plate 1, fig. 21; Plate 3, fig. 42.

General coloration of thorax yellow; abdomen yellow, the outer segments black; femora black, tibiæ brown; wings strongly tinged with yellow.

Male.—Length, about 7.5 millimeters; wing, 8.5 to 9.

Female.—Length, about 7.5 millimeters; wing, 10.

Rostrum and palpi dark brown. Antennæ dark brown throughout. Head dark brownish gray.

Pronotum and mesonotum almost uniformly yellow, the præscutum in front slightly more brownish yellow. Pleura yellow, the ventral sternopleurite brownish black, sparsely pruinose. Halteres pale yellow, the apices of the knobs weakly darkened. Legs with the fore and middle coxæ weakly darkened, the posterior coxæ yellow; trochanters yellow; femora black; tibiæ brown, the fore pair much darker than the posterior tibiæ; tarsi black. Wings (Plate 1, fig. 21) strongly tinged with yellow, the stigmal area clearer yellow, faintly encircled by dusky; virtually all longitudinal veins very narrowly bordered by dusky, especially 2d A; veins dark, C and Sc yellow. Venation as discussed under the genus.

Abdomen (male) with basal seven segments chiefly light yellow; remaining segments, including the massive hypopygium, black. In the female, the outer three segments blackened; ovipositor with yellow valves. Male hypopygium (Plate 3, fig. 42) unusually large and massive, the ninth segment appearing as a blackened cylinder, with the tergite and sternite fused; basistyle deeply embedded in the sternite, the suture not clear, but indicated by an impressed line; caudal margin of tergal region emarginate. A semipendant fleshy lobe, *m*, from the membrane at ventral suture of the basistyle.

Habitat.—China (Szechwan).

Holotype, male, Wei Chow, 65 miles northwest of Chengtu, altitude 15,200 feet, August 14, 1933 (*Graham*). Allotopotype, female, altitude 9,000 to 12,500 feet, August 15, 1933. Paratopotype, male, with the allotype.

The further unique characters of this insect have been discussed under the generic characterization.

ERIOPTERINI

CRYPTERIA SPECTRALIS sp. nov. Plate 1, fig. 22; Plate 3, fig. 43.

General coloration almost white; antennal scape and pedicel dark brown, flagellum white; præscutum with a dark brown pat-

tern; legs white, the tips of the femora and tibiæ conspicuously brownish black; sclerites of leg with long, conspicuous, erect setæ; wings whitish subhyaline, with a restricted but very conspicuous dark brown pattern; Rs nearly square at origin; abdomen yellowish white, the genital segment and a spot on tergite four black.

Male.—Length, 5 to 5.5 millimeters; wing, 7 to 7.5.

Female.—Length, 6 to 6.5 millimeters; wing, 7 to 7.5.

Rostrum and palpi dark brown. Antennæ short in both sexes; scape and pedicel dark brown; flagellum whitish; antennæ with nine free flagellar segments beyond the elongate fusion segment; flagellar verticils much longer than the segments. Head light ashen gray.

Pronotum whitish. Mesonotal præscutum whitish, with a peculiar and very conspicuous dark brown pattern, including a pair of oval spots at near midlength of the segment, one on either side of the median line, and a broad sublateral area that extends behind onto the lateral border of the scutum and as a short spur along the suture; posterior sclerites of notum white. Pleura white. Halteres yellowish white throughout. Legs with the coxæ and trochanters white; fore femora and tibiæ snowy white, the tips broadly and conspicuously brownish black, the amount subequal on the two segments; on middle and posterior legs, the femoral tips are narrowly and less conspicuously darkened, the tibial tips similarly darkened, the latter area approximately twice as extensive as the former; tarsi snowy white, the outer segments dark brown; segments of leg with very long, outspreading setæ, white on the pale areas, dark brown on the darkened portions. Wings (Plate 1, fig. 22) whitish subhyaline, restrictedly but very strikingly patterned with dark brown, including a spot at origin of Rs and along the cord, more expanded on anterior cord; much narrower dark seams on Sc_2, R_2, and m; veins white, brownish black in the darkened areas. Macrotrichia of veins long and conspicuous. Venation: Sc_1 ending just before R_2, Sc_2 just beyond fork of Rs; Rs long, nearly square at origin; R_{1+2} elongate, considerably longer than R_{2+3+4}; R_{2+3} subequal to m-cu; cell M_1 short-petiolate; m-cu at or close to fork of M; vein 2d A very long, ending at near midlength of the wing, which is widest at this point.

Abdomen yellowish white, the genital segments in both sexes blackened; posterior borders of the segments narrowly more whitish; a velvety black spot covers most of disk of the fourth

tergite. Male hypopygium (Plate 3, fig. 43) with the basistyle, *b*, cylindrical, simple; outer dististyle, *od*, slender, the tip decurved into a slender spine; outer margin before apical spine with four or five slender appressed spines; inner dististyle, *id*, a little longer than the outer, very gradually narrowed outwardly. Gonapophyses, *g*, small, blackened, gently curved, the tips bifid, the outer spine a little larger and more powerful than the inner. Ædeagus small.

Habitat.—China (Szechwan).

Holotype, male, Beh Luh Din, 30 miles north of Chengtu, altitude 6,000 feet, September 1, 1933 (*Graham*). Allotopotype, female. Paratopotypes, 7 males and females, August 16 to September 1, 1933.

The genus had not been recorded from China. This striking spectral insect requires no comparison with any described crane fly. I refer it to *Crypteria* chiefly on the venation, as the elongate vein 2d A and the position of m-cu. The only regional *Crypteria* is *C. claripennis* (Brunetti), readily told from the present fly by the entirely clear wings. The genera and subgenera of the Cladurariа are now highly involved and our conceptions of the interrelationships will surely be changed as further types are discovered. The most recent general discussion is by Soot-Ryen,[6] which gives an excellent account of our present knowledge of the group.

RHABDOMASTIX (SACANDAGA) HOLOMELANIA sp. nov. Plate 1, fig. 23.

General coloration black, the thorax sparsely pruinose; antennæ, halteres, and legs black throughout; wings with a strong dusky tinge, the stigma poorly indicated, a little darker than the ground color; macrotrichia lacking on Rs, R_{2+3+4}, R_3, and R_4; Sc_1 ending opposite midlength of Rs; m-cu beyond midlength of cell 1st M_2.

Male.—Length, 4.2 to 4.4 millimeters; wing, 4.8 to 5.

Female.—Length, about 5 millimeters; wing, 5.

Rostrum and palpi black. Antennæ relatively short in both sexes, if bent backward not attaining the wing root; flagellar segments oval. Head black.

Entire thorax, including pleura, black, the surface sparsely pruinose. Halteres black throughout. Legs black. Wings (Plate 1, fig. 23) with a strong dusky tinge; stigma poorly in-

[6] Diptera from Arctic Siberia. The Norwegian North Polar Expedition with the "Maud." 1918–1925, Scientific results 5 No. 5 (1928) 4–6.

dicated, a little darker than the ground color; veins dark brown. Macrotrichia lacking on veins Rs, R_{2+3+4}, R_3, and R_4, excepting an occasional one on the last vein. Venation: Sc_1 ending about opposite midlength of Rs, Sc_2 a short distance from its tip; R_3 suberect, approximately twice its length beyond tip of R_{1+2}; R_4 arcuated, subequal in length to petiole of cell R_3; m-cu at from beyond midlength to near two-thirds the length of cell 1st M_2.

Abdomen black throughout.

Habitat.—China (Szechwan).

Holotype, male, Kwanhsien, altitude 2,000 to 4,000 feet, May 15 to 31, 1933 (*Graham*). Allotopotype, female. Paratopotypes, 2 males.

Rhabdomastix (*Sacandaga*) *holomelania* is most nearly allied to *R.* (*S.*) *minicola* Alexander (western China), which has the venation somewhat similar, differing in the uniformly blackened halteres of the present insect and in certain venational details, as the relation of vein R_3 to the tip of R_{1+2} and the position of m-cu some distance beyond midlength of cell 1st M_2.

MOLOPHILUS NIGROPOLITUS sp. nov. Plate 1, fig. 24; Plate 3, fig. 44.

Belongs to the *gracilis* group and subgroup; allied to *albibasis;* thorax and abdomen polished black; head dull gray; wings white, the prearcular field light yellow: vein 2d A short, ending approximately opposite the origin of Rs; male hypopygium with the tergite conspicuous, its apical portion narrowed into a depressed lobe, the margin of which is evenly, microscopically serrulate.

Male.—Length, 3.8 to 4.2 millimeters; wing, 4.6 to 5.

Rostrum and palpi black. Antennæ short, if bent backward not attaining the wing root, black throughout. Head uniformly dull gray.

Thorax uniformly polished black, only the restricted anterolateral pretergites and the dorsopleural membrane yellow. Halteres white, the knobs weakly more yellowish. Legs with the coxæ blackened; trochanters obscure yellow; femora black, their bases yellow, involving the basal fourth or approximately so; remainder of legs black. Wings (Plate 1, fig. 24) white, the prearcular field light yellow; veins conspicuous, dark brown. Venation: Sc_1 ending opposite R_2, Sc_2 only a short distance beyond origin of Rs; petiole of cell M_3 about twice the gently sinuous m-cu; vein 2d A short, ending opposite, or just beyond, origin of Rs.

Abdomen, including hypopygium, polished black. Male hypopygium (Plate 3, fig. 44) with the tergite, 9*t*, conspicuous, the apical portion strongly narrowed into a depressed lobe, its margin evenly and microscopically serrulate; surface of tergite at base of lobe with long conspicuous setæ that exceed the lobe in length. Dorsal lobe *db*, of basistyle with apex very strongly curved upon itself to form an almost complete turn, the apex a slender black spine, with conspicuous pale membrane at base of spine. Inner dististyle, *id*, with the two arms long and slender.

Habitat.—China (Szechwan).

Holotype, male, Kwanhsien, altitude 2,000 to 4,000 feet, May 15 to 31, 1933 (*Graham*). Paratopotype, male.

The nearest known ally of the present fly is *Molophilus albibasis* Alexander (Saghalien), which is readily told by the less-polished body coloration, the uniformly blackened legs, and the distinct male hypopygium. I have illustrated the latter for comparison with the present fly (Plate 3, fig. 45). Note the difference in the conformation of the tergal lobe, which is expanded at apex and with the margin coarsely and irregularly serrate.

ILLUSTRATIONS

[Legend: *b*, Basistyle; *d*, dististyle; *db*, dorsal lobe of basistyle; *g*, gonapophysis; *i*, interbase; *id*, inner dististyle; *m*, median appendage of ninth sternite; *od*, outer dististyle; *s*, sternite; *t*, tergite; *vd*, ventral dististyle.]

PLATE 1

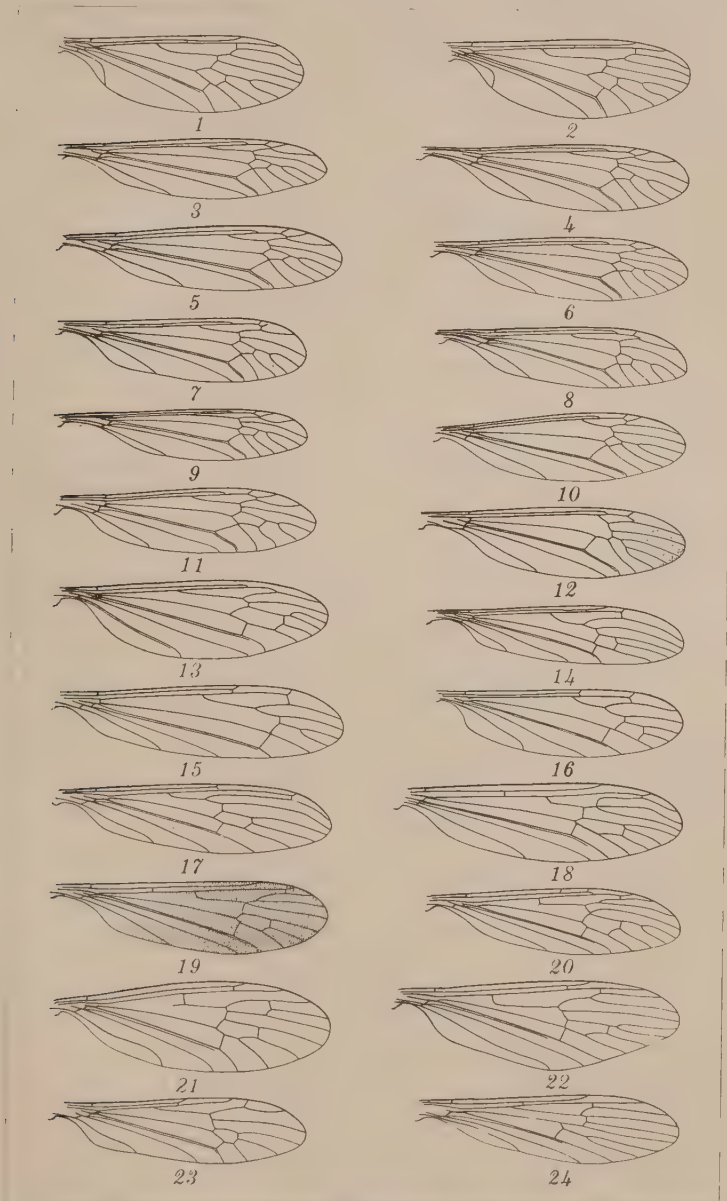
FIG. 1. *Trichocera sapporensis* sp. nov.; venation.
2. *Trichocera szechwanensis* sp. nov.; venation.
3. *Tipula* (*Vestiplex*) *optanda* sp. nov.; venation.
4. *Tipula* (*Vestiplex*) *immota* sp. nov.; venation.
5. *Tipula* (*Oreomyza*) *coxitalis* sp. nov.; venation.
6. *Tipula* (*Oreomyza*) *sternotuberculata* sp. nov.; venation.
7. *Tipula* (*Oreomyza*) *resupina* sp. nov.; venation.
8. *Tipula* (*Oreomyza*) *excetra* sp. nov.; venation.
9. *Tipula* (*Lunatipula*) *multisetosa* sp. nov.; venation.
10. *Tipula* (*Schummelia*) *strictiva* sp. nov.; venation.
11. *Tipula sindensis* sp. nov.; venation.
12. *Dolichopeza* (*Sinoropeza*) *pluricoma* sp. nov.; venation.
13. *Cylindrotoma aurantia* sp. nov.; venation.
14. *Limonia* (*Libnotes*) *immetata* sp. nov.; venation.
15. *Limonia* (*Limonia*) *tuta* sp. nov.; venation.
16. *Limonia* (*Rhipidia*) *synspilota* sp. nov.; venation.
17. *Dicranoptycha vulpes* sp. nov.; venation.
18. *Nipponomyia szechwanensis* sp. nov.; venation.
19. *Ula comes* sp. nov.; venation.
20. *Epiphragma* (*Epiphragma*) *bicinctifera* sp. nov.; venation.
21. *Grahamomyia bicellula* gen. et sp. nov.; venation.
22. *Crypteria spectralis* sp. nov.; venation.
23. *Rhabdomastix* (*Sacandaga*) *holomelania* sp. nov.; venation.
24. *Molophilus nigropolitus* sp. nov.; venation.

PLATE 2

FIG. 25. *Trichocera sapporensis* sp. nov.; male hypopygium.
26. *Trichocera szechwanensis* sp. nov.; male hypopygium.
27. *Tipula* (*Vestiplex*) *optanda* sp. nov.; male hypopygium, details.
28. *Tipula* (*Vestiplex*) *optanda* sp. nov.; male hypopygium, details.
29. *Tipula* (*Vestiplex*) *immota* sp. nov.; male hypopygium, details.
30. *Tipula* (*Oreomyza*) *coxitalis* sp. nov.; male hypopygium, details.
31. *Tipula* (*Oreomyza*) *coxitalis* sp. nov.; male hypopygium, details.
32. *Tipula* (*Oreomyza*) *sternotuberculata* sp. nov.; male hypopygium, details.
33. *Tipula* (*Oreomyza*) *sternotuberculata* sp. nov.; male hypopygium, details.
34. *Tipula* (*Oreomyza*) *resupina* sp. nov.; male hypopygium, details.

PLATE 3

FIG. 35. *Tipula* (*Lunatipula*) *multisetosa* sp. nov.; male hypopygium, details.
36. *Tipula* (*Lunatipula*) *multisetosa* sp. nov.; male hypopygium, details.
37. *Tipula sindensis* sp. nov.; male hypopygium, dististyles.
38. *Limonia* (*Libnotes*) *immetata* sp. nov.; male hypopygium.
39. *Limonia* (*Rhipidia*) *synspilota* sp. nov.; male hypopygium.
40. *Nipponomyia szechwanensis* sp. nov.; male hypopygium.
41. *Epiphragma* (*Epiphragma*) *bicinctifera* sp. nov.; male hypopygium.
42. *Grahamomyia bicellula* gen. et sp. nov.; male hypopygium.
43. *Crypteria spectralis* sp. nov.; male hypopygium.
44. *Molophilus nigropolitus* sp. nov.; male hypopygium.
45. *Molophilus albibasis* Alexander; male hypopygium.



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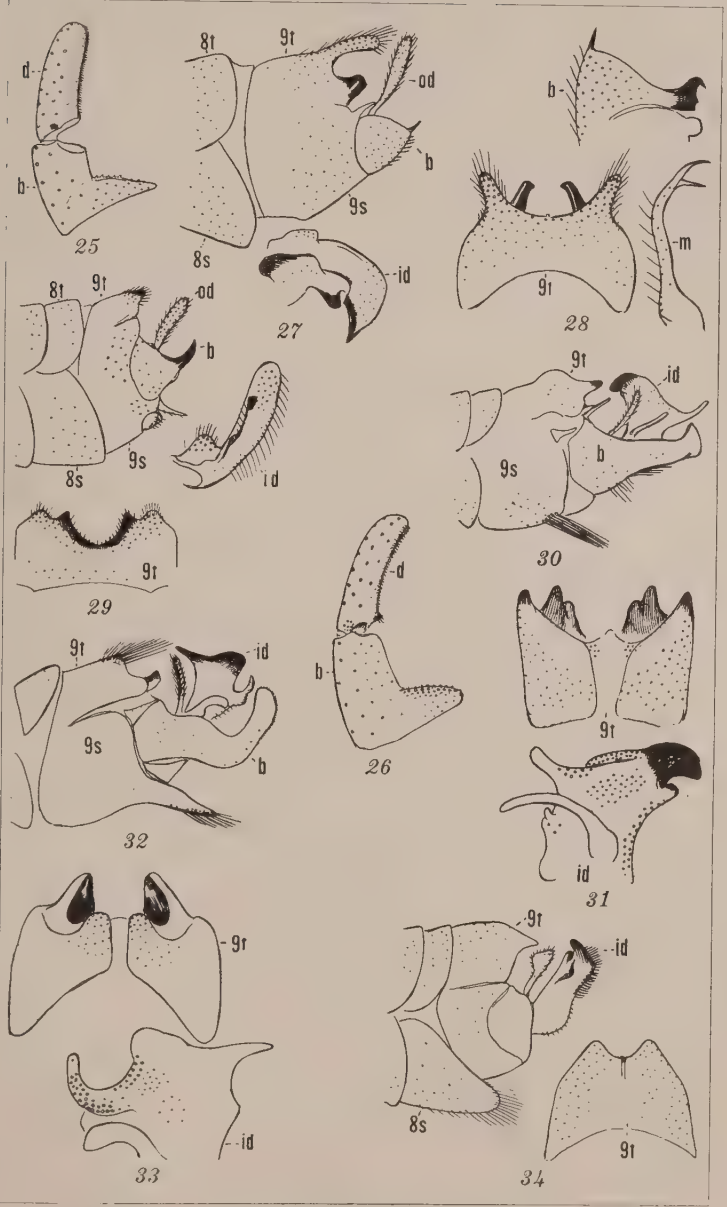
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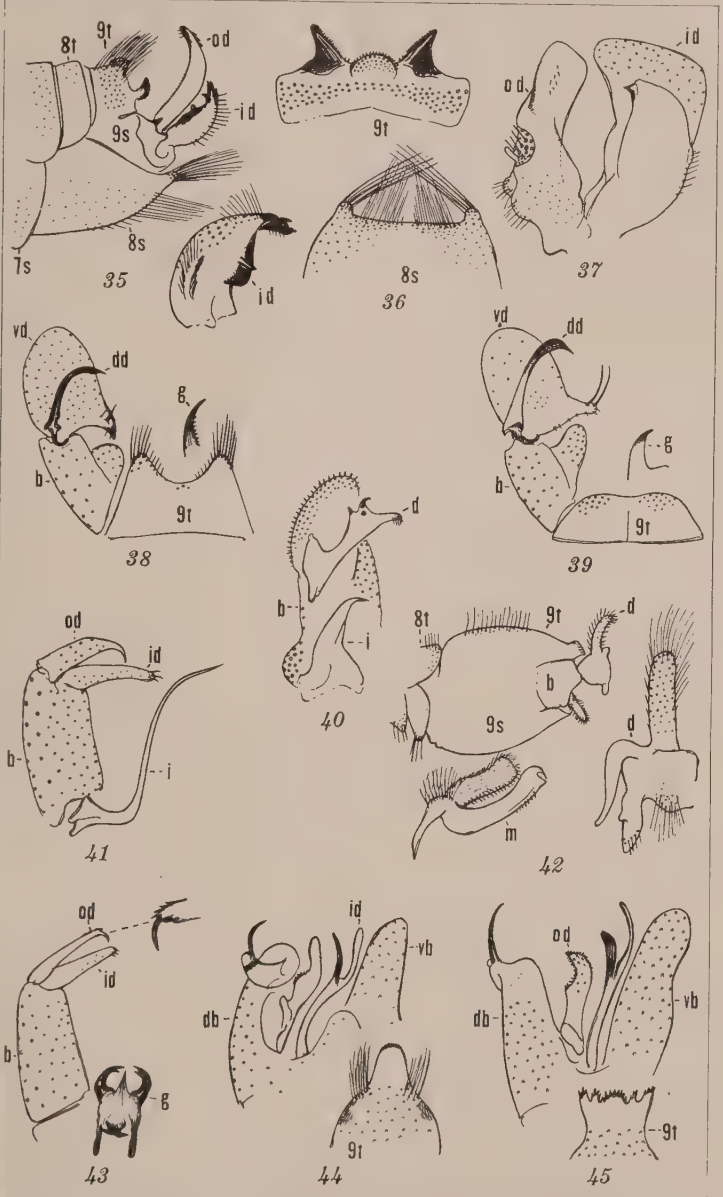
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PLATE 3.

ERRATUM

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[New names and new combinations are printed in **boldface.**]

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